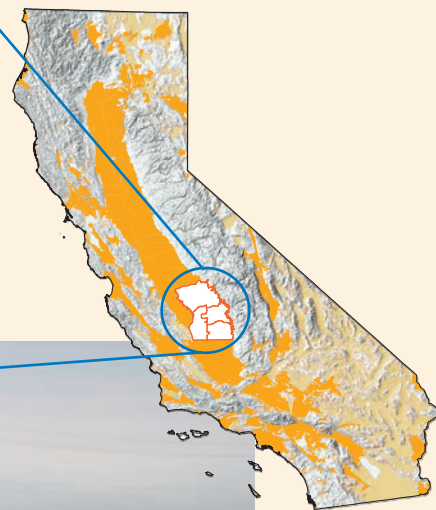
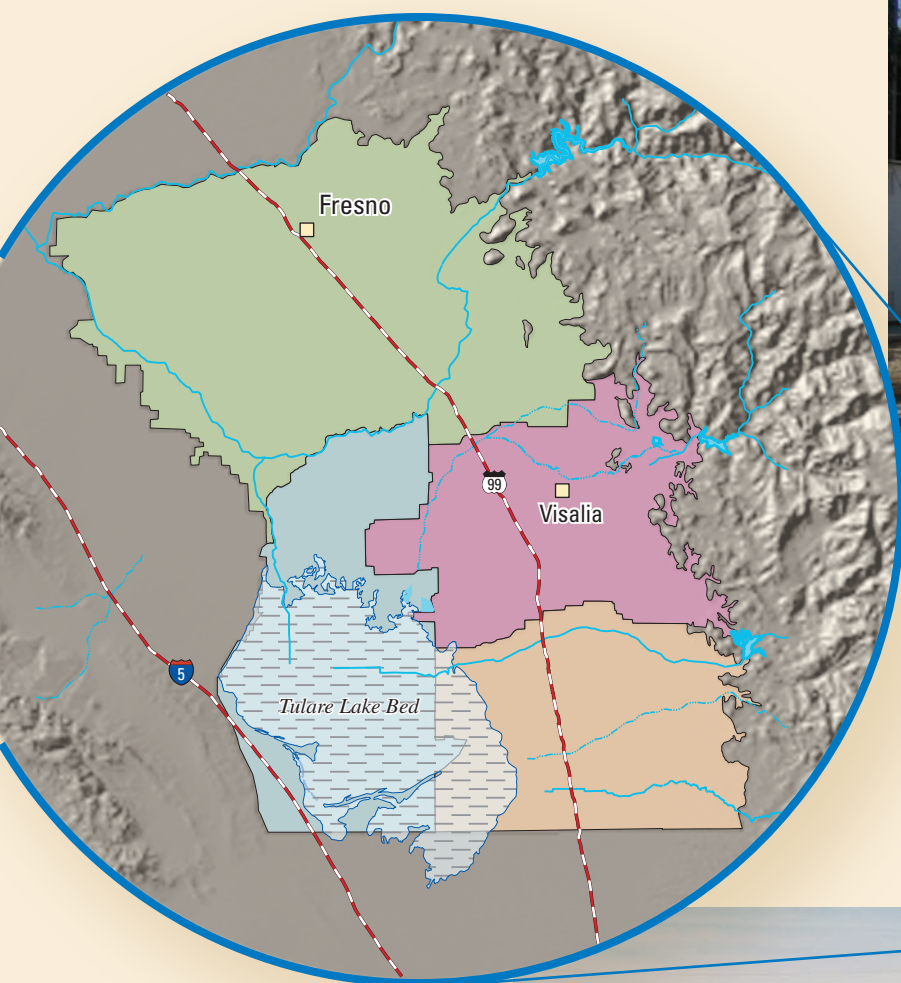


In cooperation with the California State Water Resources Control Board

A product of the California Groundwater Ambient Monitoring and Assessment (GAMA) Program

Ground-Water Quality Data in the Southeast San Joaquin Valley, 2005–2006—Results from the California GAMA Program



Data Series 351

U.S. Department of the Interior
U.S. Geological Survey



Ground-Water Quality Data in the Southeast San Joaquin Valley, 2005–2006—Results from the California GAMA Program

By Carmen A. Burton and Kenneth Belitz

Prepared in cooperation with the California State Water Resources Control Board

Data Series 351

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Suggested citation:

Burton, C.A., and Belitz, Kenneth, 2008, Ground-water quality data in the southeast San Joaquin Valley, 2005–2006—Results from the California GAMA Program: U.S. Geological Survey Data Series 351, 103 p. Available at <http://pubs.usgs.gov/ds/351/>

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Abbreviations and Acronyms

AB	Assembly Bill (through the California State Assembly)
AL	Action Level
CAS	Chemical Abstract Service (American Chemical Society)
CSU	combined standard uncertainty
D	detected
DIW	deionized water
E	estimated value or having a higher degree of uncertainty
GAMA	Groundwater Ambient Monitoring and Assessment program
GPS	Global positioning system
HAL	Lifetime Health Advisory (USEPA)
HPLC	high-performance liquid chromatography
Hwy99T	Highway 99 transect well
KINGFP	Kings study area flow-path well
KWH	Kaweah study area
KING	Kings study area
LRL	laboratory reporting level
LSD	land-surface datum
LT-MDL	long-term method detection level
MCL-CA	maximum contaminant level (CDPH)
MCL-US	maximum contaminant level (USEPA)
MDL	method detection limit
MRL	minimum reporting level
MW	monitoring well
na	not available; not applicable
nc	sample not collected
nd	no data
NELAP	National Environmental Laboratory Accreditation Program
NL-CA	California Department of Public Health notification level (CDPH)
nr	not reported
NTU	nephelometric turbidity unit
NWIS	National Water Information System (USGS)
PCFF-GAMA	Personal Computer Field Forms program designed for GAMA sampling
QA	quality assurance
QC	quality control
RSD	relative standard deviation
RSD5	risk-specific dose at 10^{-5} (USEPA)
SESJ	Southeast San Joaquin Valley study unit
SMCL-CA	secondary maximum contaminant level (CDPH)
SMCL-US	secondary maximum contaminant level (USEPA)
SMOW	secondary Standard Mean Ocean Water
SSMDC	sample-specific minimum detectable concentration
TT-US	treatment technique (USEPA) – a required process intended to reduce the level of a contaminant in drinking water
TLR	Tulare Lake study area
TULE	Tule study area
V	analyte detected in sample and an associated blank, thus data are not included in ground-water quality assessment
VPDB	Vienna Pee Dee Belemnite
VSMOW	Vienna Standard Mean Ocean Water
*	value is above threshold
—	not detected

Organizations

CDPH	California Department of Public Health (was California Department of Health Services until July 1, 2007)
CADWR	California Department of Water Resources
LLNL	Lawrence Livermore National Laboratory
MWH	Montgomery-Watson-Harza Laboratory
NAWQA	National Water-Quality Assessment (USGS)
NWQL	National Water Quality Laboratory (USGS)
SITL	U.S. Geological Survey Stable Isotope and Tritium Laboratory
SWRCB	State Water Resources Control Board (California)
TML	U.S. Geological Survey Trace Metal Laboratory
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey

Selected chemical names

DBCP	1,2-dibromo-3-chloropropane
DO	dissolved oxygen
DOC	dissolved organic carbon
EDB	1,2-dibromoethane
HCl	hydrochloric acid
MTBE	methyl <i>tert</i> -butyl ether
NDMA	<i>N</i> -nitrosodimethylamine
PCE	tetrachloroethene
SC	specific conductance
1,2,3-TCP	1,2,3-trichloropropane
TDS	total dissolved solids
THM	trihalomethane
VOC	volatile organic compound

Units of Measure

cm ³ STP/g	cubic centimeters at standard temperature and pressure (0 degrees Celsius and 1 atmosphere of pressure) per gram of water
δiE	standard delta notation, the ratio of a heavier isotope of an element (iE) to the more common lighter isotope of that element, relative to a standard reference material, expressed in per mil
ft	foot (feet)
in.	inch (inches)
kg	kilogram
km ²	square kilometers
L	liter
mg	milligram
mg/L	milligrams per liter
mi	miles
mi ²	square miles
mL	milliliter
mm	millimeter
μg/L	micrograms per liter
μL	microliter
μm	micrometer
μS/cm	microSiemens per centimeter

pCi/L	picocuries per liter
per mil	parts per thousand
ppb	parts per billion (µg/L)
ppm	parts per million (mg/L)

Notes

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

$$^{\circ}\text{F}=(1.8\times^{\circ}\text{C})+32$$

Vertical coordinate information is referenced to North American Vertical Datum of 1988 (NAVD 88).

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Altitude, as used in this report, refers to distance above the vertical datum.

Specific conductance is given in microsiemens per centimeter at 25 degrees Celsius (µS/cm at 25°C).

Concentrations of chemical constituents in water are given either in milligrams per liter (mg/L) or micrograms per liter (µg/L). Milligrams per liter is equivalent to parts per million (ppm) and micrograms per liter is equivalent to parts per billion (ppb).

Ground-Water Quality Data in the Southeast San Joaquin Valley, 2005–2006—Results from the California GAMA Program

By Carmen A. Burton and Kenneth Belitz

Abstract

Ground-water quality in the approximately 3,800 square-mile Southeast San Joaquin Valley study unit (SESJ) was investigated from October 2005 through February 2006 as part of the Priority Basin Assessment Project of Ground-Water Ambient Monitoring and Assessment (GAMA) Program. The GAMA Statewide Basin Assessment project was developed in response to the Ground-Water Quality Monitoring Act of 2001 and is being conducted by the California State Water Resources Control Board (SWRCB) in collaboration with the U.S. Geological Survey (USGS) and the Lawrence Livermore National Laboratory (LLNL).

The SESJ study was designed to provide a spatially unbiased assessment of raw ground-water quality within SESJ, as well as a statistically consistent basis for comparing water quality throughout California. Samples were collected from 99 wells in Fresno, Tulare, and Kings Counties, 83 of which were selected using a spatially distributed, randomized grid-based method to provide statistical representation of the study area (grid wells), and 16 of which were sampled to evaluate changes in water chemistry along ground-water flow paths or across alluvial fans (understanding wells).

The ground-water samples were analyzed for a large number of synthetic organic constituents (volatile organic compounds [VOCs], pesticides and pesticide degradates, and pharmaceutical compounds), constituents of special interest (perchlorate, *N*-nitrosodimethylamine, and 1,2,3-trichloropropane), naturally occurring inorganic constituents (nutrients, major and minor ions, and trace elements), radioactive constituents, and microbial indicators. Naturally occurring isotopes (tritium, and carbon-14, and stable isotopes of hydrogen, oxygen, nitrogen, and carbon), and dissolved noble gases also were measured to help identify the source and age of the sampled ground water.

Quality-control samples (blanks, replicates, samples for matrix spikes) were collected at approximately 10 percent of the wells, and the results for these samples were used to

evaluate the quality of the data for the ground-water samples. Assessment of the quality-control data resulted in censoring of less than 1 percent of the detections of constituents measured in ground-water samples.

This study did not attempt to evaluate the quality of drinking water delivered to consumers; after withdrawal from the ground, water typically is treated, disinfected, and (or) blended with other waters to maintain acceptable drinking-water quality. Regulatory thresholds apply to the treated water that is served to the consumer, not to raw ground water. However, to provide some context for the results, concentrations of constituents measured in the raw ground water were compared with regulatory and other health-based thresholds established by the U.S. Environmental Protection Agency and California Department of Public Health (CDPH) and thresholds established for aesthetic concerns by CDPH.

Two VOCs were detected above health-based thresholds: 1,2-dibromo-3-chloropropane (DBCP), and benzene. DBCP was detected above the U.S. Environmental Protection Agency's maximum contaminant level (MCL-US) in three grid wells and five understanding wells. Benzene was detected above the CDPH's maximum contaminant level (MCL-CA) in one grid well. All pesticide detections were below health-based thresholds. Perchlorate was detected above its maximum contaminant level for California in one grid well. Nitrate was detected above the MCL-US in six samples from understanding wells, of which one was a public supply well. Two trace elements were detected above MCLs-US: arsenic and uranium. Arsenic was detected above the MCL-US in four grid wells and two understanding wells; uranium was detected above the MCL-US in one grid well and one understanding well. Gross alpha radiation was detected above MCLs-US in five samples; four of them understanding wells, and uranium isotope activity was greater than the MCL-US for one understanding well. Radon-222 was detected above the proposed MCL-US in all wells sampled. Total coliforms were detected in two wells and somatic coliphage was detected in one well.

Introduction

Ground water comprises nearly half of the water used for public-supply in California (Hutson and others, 2004). To assess the quality of ground water from public-supply wells and establish a program for monitoring trends in ground-water quality, the State Water Resources Control Board (SWRCB), in collaboration with the U.S. Geological Survey (USGS) and Lawrence Livermore National Laboratory (LLNL), implemented a statewide Groundwater Ambient Monitoring and Assessment (GAMA) program (<http://www.swrcb.ca.gov/gama/>). The GAMA program consists of three projects: Priority Basin Assessment, conducted by the USGS (<http://ca.water.usgs.gov/gama/>); Voluntary Domestic Well Assessment, conducted by the SWRCB; and Special Studies, conducted by LLNL.

The SWRCB initiated the GAMA Priority Basin Assessment project in response to the Ground-Water Quality Monitoring Act of 2001 [Sections 10780–10782.3 of the California Water Code, Assembly Bill (AB) 599]. AB 599 is a public mandate to assess and monitor the quality of ground water used for public supply in California. The project is a comprehensive assessment of statewide ground-water quality designed to help better understand and identify risks to ground-water resources, and to increase the availability of information about ground-water quality to the public. The USGS, as part of the AB 599 process and in collaboration with the SWRCB, developed the monitoring plan for the project (Belitz and others, 2003). A key aspect of the project is inter-agency collaboration and cooperation with local water agencies and well owners. Local participation in the project is entirely voluntary.

The GAMA Priority Basin Assessment project is unique because the data collected during the study include analyses for an extensive number of chemical constituents at very low concentrations, analyses that are not normally available. A broader understanding of ground-water composition will be especially useful for providing an early indication of changes in water quality and for identifying the natural and human factors affecting water quality. Additionally, the GAMA Priority Basin Assessment project will analyze a broader suite of constituents than required by the California Department of Public Health (CDPH, formerly the California Department of Health Services). An understanding of the occurrence and distribution of these constituents is important for the long-term management and protection of ground-water resources.

The range of hydrologic, geologic, and climatic conditions that exist in California must be considered in an assessment of ground-water quality. Belitz and others (2003) partitioned the state into 10 hydrogeologic provinces, each with distinctive hydrologic, geologic, and climatic characteristics (fig. 1). Eighty percent of California's approximately 16,000 public-supply wells are located in ground-water basins within these 10 hydrogeologic provinces. These ground-water basins, defined by the California

Department of Water Resources (CADWR), generally consist of relatively permeable, unconsolidated deposits of alluvial or volcanic origin (California Department of Water Resources, 2003). Ground-water basins were prioritized for sampling based on the number of public-supply wells in the basin (Belitz and others, 2003). Secondary consideration was given to municipal ground-water use, agricultural pumping, the number of leaking underground fuel tanks, and pesticide application within a basin. In addition, some ground-water basins or groups of adjacent similar basins with relatively few public-supply wells were assigned high priority so that all hydrogeologic provinces would be represented in the subset of basins sampled. The 116 priority basins were grouped into 35 study units. Some areas not in the defined ground-water basins were included in several of the study units to achieve representation of the 20 percent of public-supply wells not located in the ground-water basins.

Three types of water-quality assessments are being conducted with the data collected in each study unit: (1) *Status*: assessment of the current quality, of the ground-water resource, (2) *Trends*: detection of changes in ground-water quality, and (3) *Understanding*: identification of the natural and human factors affecting ground-water quality (Kulongoski and Belitz, 2004). This report is one of a series of reports presenting the *status* of current water-quality conditions in each study unit (Wright and others, 2005; Bennett and others, 2006; Kulongoski and others, 2006; Fram and Belitz, 2007; Kulongoski and Belitz, 2007; and Dawson and others, 2008). Subsequent interpretive reports will address the *trends* and *understanding* aspects of the water-quality assessments.

The Southeast San Joaquin Valley study unit, hereafter referred to as SESJ, is comprised of four ground-water subbasins located in the San Joaquin ground-water basin. Ground water is the sole source of public supply for many of the cities located in the SESJ (Water Education Foundation, 2006, <http://www.water-ed.org/watersources/default.asp>). Therefore, SESJ study unit was selected as a high priority for sampling, to provide adequate characterization of Central Valley ground-water quality (Belitz and others, 2003).

Purpose and Scope

The purposes of this report are: (1) to describe the study design and methods of the SESJ study unit, (2) to present the results of quality-control tests, and (3) to present the analytical results for ground-water samples collected in the SESJ study unit. Ground-water samples were analyzed for organic, inorganic, and microbial constituents, general water-quality indicators, and chemical tracers. Samples for pharmaceutical compounds also were collected as part of this study; however, the presentation of these results and their associated Quality Assurance/Quality Control are beyond the scope of this report and will be presented in a future report.



Shaded relief derived from U.S. Geological Survey
National Elevation Dataset, 2006.
Albers Equal Area Conic Projection

Provinces from Belitz and others, 2003.

Figure 1. The hydrogeologic provinces of California GAMA study and the location of the Southeast San Joaquin Valley Groundwater Ambient Monitoring and Assessment (GAMA) study unit. (Modified from Belitz and others, 2003).

The chemical and microbial data presented in this report were evaluated by comparison to State and Federal drinking-water regulatory thresholds and other health-based standards that are applied to treated drinking water. Regulatory thresholds considered for this report are those established by the U.S. Environmental Protection Agency (USEPA) and the California Department of Public Health (CDPH). The data presented in this report are intended to characterize the quality of untreated ground-water resources within the study unit, not the treated drinking water delivered to consumers by water purveyors. Discussions of the factors that influence the distribution and occurrence of the constituents detected in ground-water samples will be the subject of subsequent publications.

Acknowledgements

The authors thank the following cooperators for their support: California State Water Resources Control Board (SWRCB), California Department of Public Health (CDPH), California Department of Water Resources (CADWR), and Lawrence Livermore National Laboratory (LLNL). We especially thank the cooperating well owners and water purveyors for their generosity in allowing the USGS to collect samples from their wells. In addition, two reviewers, Jan Stepek (SWRCB) and Timothy G. Rowe (USGS), provided comments to improve this work. Funding for this work was provided by State bonds authorized by Proposition 50 and administered by the SWRCB.

Hydrogeologic Setting of the Southeast San Joaquin Valley Study Unit

The Southeast San Joaquin (SESJ) study unit covers approximately 3,780 mi² (9,790 km²) in the San Joaquin Valley ground-water basin of the Central Valley hydrogeologic province, as described by Belitz and others (2003) ([fig. 1](#)). The study unit is bounded by the San Joaquin River on the north, the Sierra Nevada s to the east, Kern County to the south, and the Kettleman Hills and the Westside and Delta-Mendota subbasins to the west ([fig. 2](#)).

SESJ has a Mediterranean climate with hot, dry summers and cool, moist winters. Average rainfall across the study unit ranges from 7 in. (18 cm) in the western portion of the study unit to 13 in. (33 cm) in the eastern portion of the study unit (California Department of Water Resources, 2006a–d). More than 90 percent of the precipitation falls between October and April. Several creeks and rivers drain the SESJ. The San Joaquin, Kings, Kaweah, and Tule Rivers are the primary streams draining the study unit but most of their flow originates in the Sierra Nevada Mountains to the east. The San

Joaquin River flows north and empties into the Sacramento–San Joaquin Delta. The Kings River is diverted to the San Joaquin River by the Fresno Slough and James Bypass. The Kaweah and Tule Rivers flow south or west toward the Tulare lakebed.

Primary sources of recharge are irrigation, seepage from rivers, streams, and irrigations canals, percolation of precipitation, urban runoff, and in the area near Fresno, engineered recharge of runoff from the nearby Sierra Nevada (California Department of Water Resources, 2003; Wright and others, 2004). Discharge from the aquifer is primarily from ground-water pumping for irrigation and public water supply. About 40 percent of the water used in the study unit comes from ground water. Most municipalities located in the study unit, such as Visalia and Tulare, use ground water as their sole source of public supply.

The study unit is divided into four study areas: the Kings study area, Kaweah study area, Tule study area, and the Tulare Lake study area. The boundaries of these study areas correspond to the ground-water subbasins of the same names in the Tulare Lake hydrologic region as described by CADWR (California Department of Water Resources, 2003) ([fig. 2](#)).

The Kings study area is composed of the Kings ground-water subbasin, which covers 1,530 mi² (3,960 km²) in Fresno County and the northern part of Kings and Tulare Counties. It is bounded to the north by the San Joaquin River, to the east by the Sierra Nevadas, to the south by the Kaweah and Tulare Lake ground-water subbasins, and to the west by the Delta-Mendota and Westside ground-water subbasins. The San Joaquin and Kings Rivers are the two major rivers within or bordering the subbasin (California Department of Water Resources, 2006a) ([fig. 2](#)).

The ground-water aquifer system consists of unconsolidated marine and continental deposits of the Tertiary and Quaternary age overlain by younger alluvial deposits of Quaternary age. The eastern two-thirds of the study area consists of the quaternary alluvial fans of the Kings River, with compound alluvial fans of intermittent streams to the north and south (Burow and others, 1997). These deposits generally are permeable. The western one-third of the study area consists of the less permeable basin deposits. Vertical flow in this area is restricted by silt and clay layers, of which the Corcoran Clay member of the Tulare formation ranging in depths of about 250–550 feet, is the most extensive (California Department of Water Resources, 2006a) ([fig. 3](#)).

The Kaweah study area is composed of the Kaweah ground-water subbasin which covers 700 mi² (1,810 km²) and is located in Tulare County. It is bounded by the Kings ground-water subbasin to the north, the Sierra Nevadas to the east, Tule ground-water subbasin to the south, and the Tulare Lake ground-water subbasin to the west. The Kaweah and St. Johns Rivers are the two major rivers within the subbasin. The primary source of ground-water recharge is the Kaweah River (California Department of Water Resources, 2006b) ([fig. 2](#)).

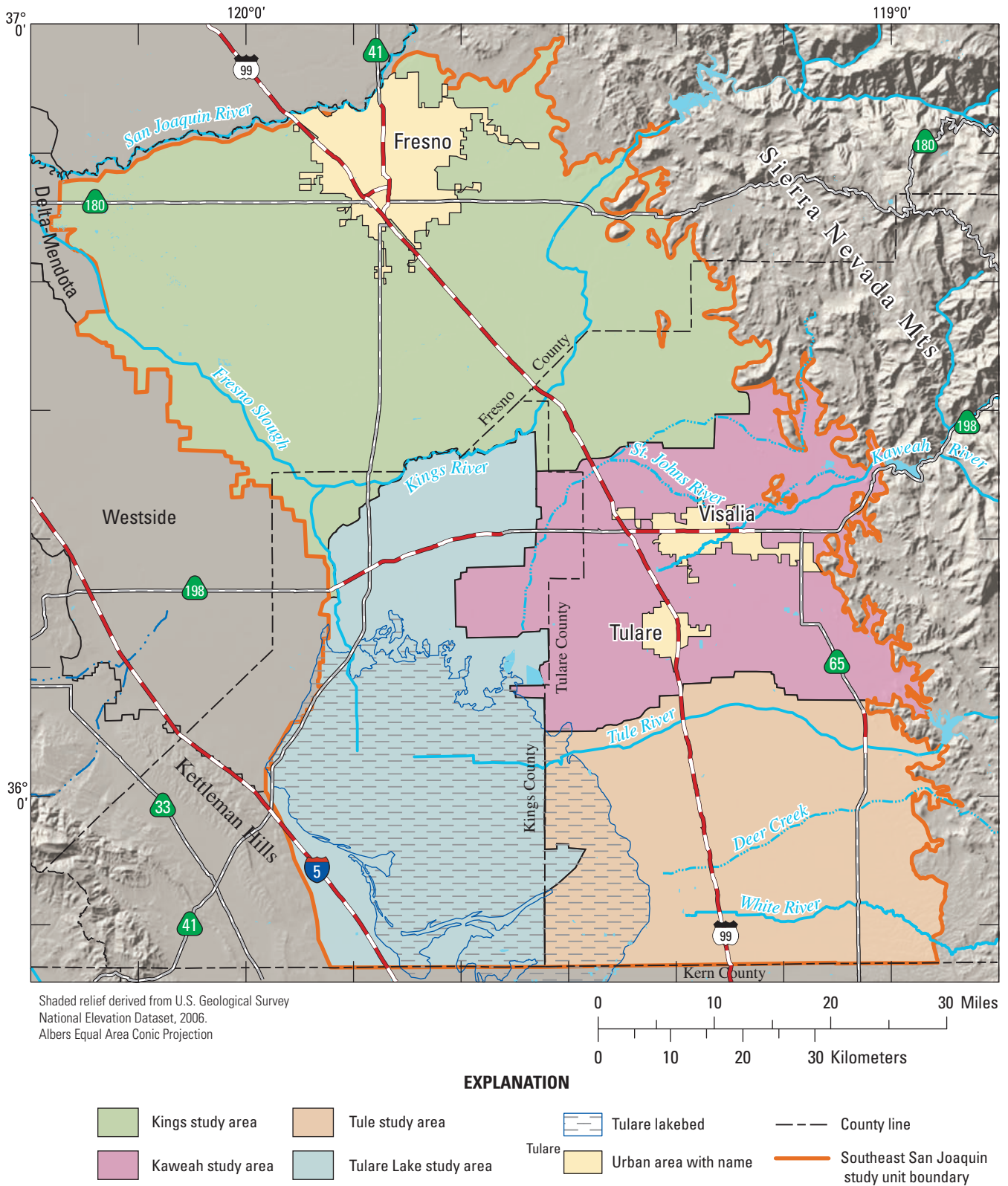


Figure 2. The Southeast San Joaquin Valley Groundwater Ambient Monitoring and Assessment (GAMA) study unit, locations of California's Department of Water Resources ground-water subbasins (study areas) within the study unit, and major hydrologic features, cities, and highways.

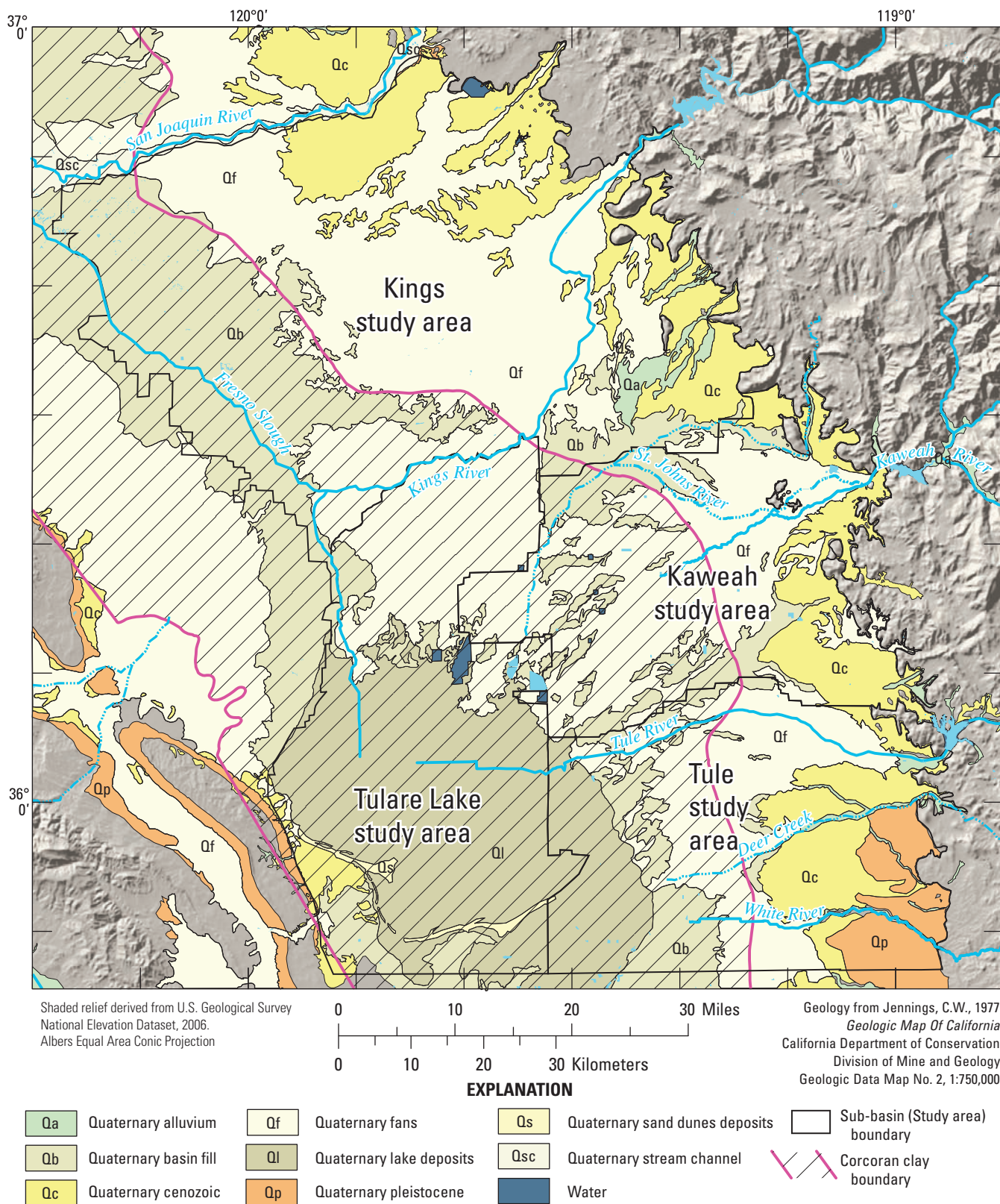


Figure 3. The four ground-water subbasins (study areas) and associated surficial geology in the Southeast San Joaquin Valley Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California.

The aquifer system of the Kaweah subbasin consists of unconsolidated marine and continental deposits of Pliocene, Pleistocene, and Holocene age. The eastern half of the subbasin consists of three stratigraphic layers: continental deposits, older alluvium, and younger alluvium. The continental deposits are from the Pliocene and Pleistocene age and are poorly permeable. The older alluvium is moderately-to-highly permeable and is the major aquifer in the subbasin. Also, the younger alluvium fan is moderately-to-highly permeable. The alluvial fan interfingers with the less permeable basin deposits in the western half of the subbasin. The ground-water aquifer is confined by the Corcoran Clay layer in the western half of the subbasin ([fig. 3](#)) (California Department of Water Resources, 2006b).

The Tule study area, located in Tulare County, is composed of the Tule ground-water subbasin and covers 730 mi² (1,900 km²). It is bounded by the Kaweah subbasin to the north, the Sierra Nevadas to the east, Kern County to the south, and the Tulare Lake subbasin and Kings County to the west. Tule River, Deer Creek, and White River are the major rivers within the subbasin, and they flow westward into the Tulare Lake bed (California Department of Water Resources, 2006c) ([fig. 2](#)).

The aquifer system of the Tule subbasin consists of continental deposits of Pliocene, Pleistocene, and Holocene age. The basin and lake deposits in the western half of the subbasin consist mainly of silt and clay and are relatively impermeable. The Corcoran Clay layer in the western half of the subbasin ([fig. 3](#)) creates a confining layer to the ground-water aquifer of the Tulare Formation. The older alluvium is very permeable and is a major aquifer in the subbasin. The younger alluvial fans are very permeable but contain little water. The continental deposits in the eastern part of the subbasin are poorly sorted deposits of clay, silt, sand, and gravel from the Sierra Nevada Mountains and are a major source of ground water (California Department of Water Resources, 2006c).

The Tulare Lake study area is composed of the Tulare Lake ground-water subbasin, which covers 820 mi² (2,120 km²) and is located in Kings County. It is bounded by the Kings subbasin to the north, the Kaweah and Tule subbasins to the east, Kern County to the south, and the Kettleman Hills and Westside ground-water subbasin to the west. The southern half of the subbasin is located in the former Tulare Lake bed (California Department of Water Resources, 2006d) ([fig. 2](#)).

The aquifer system of the Tulare Lake subbasin consists of older and younger alluvium, and continental deposits. Continental deposits are poorly sorted deposits of clay, sand, and gravel; their permeability is low-to-moderate. Older alluvium is poorly sorted deposits of clay, sand, silt, and gravel. The older alluvium is moderately to highly permeable and is a major aquifer in the subbasin. The younger alluvium consists of sorted and unsorted beds of clay, sand, silt and gravel. The younger alluvium is very permeable but lies above the water table. Flood-basin and lake deposits, which include

the Corcoran Clay layer, are not an important source of ground water in the subbasin (California Department of Water Resources, 2006d) ([fig. 3](#)).

Methods and Quality Assurance and Quality Control

Methods used for the GAMA program were selected to provide: (1) a sampling design suitable for statistical analyses; (2) sample collection in a consistent manner; (3) samples analyzed using proven and reliable laboratory methods; (4) assurance of the quality of the ground-water data; and (5) a secure data archive with appropriate documentation.

Study Design

The wells selected for sampling in this study reflect the combination of two well selection strategies. Eighty-three wells were selected to provide a statistically unbiased, spatially distributed assessment of the quality of ground-water resources used for public drinking-water supply, and 16 additional wells were selected to provide greater sampling density in several areas to address specific ground-water quality issues in the study unit.

The spatially distributed wells were selected using a spatially distributed, randomized grid-based method (Scott, 1990). Each of the study areas was subdivided into grid cells approximately 38 mi² (100 km²) ([fig. 4](#)) with the minimum number of 20 grid cells in a study area. Based on the size of the study areas, the Kings study area was divided into 40 grid cells, the Kaweah and Tule study areas each were divided into 20 grid cells, and Tulare Lake study area was divided into 22 grid cells.

Initial target wells were obtained from statewide databases maintained by the CDPH and the USGS. If a grid cell contained more than one public-supply well, each well in that grid cell was randomly assigned a rank. In each grid cell with multiple wells, the highest ranked well was given priority for sampling. An attempt was made to select one well per grid cell, but some grid cells did not contain accessible wells. Wells from adjacent cells were selected to account for grid cells that had no active wells. In this fashion, a public-supply well was randomly selected from each cell to provide a spatially distributed, randomized monitoring network for each study area. If a public-supply well was not available in a cell, an irrigation well was selected. If an irrigation well was not available, a domestic well was sampled. Wells sampled as part of the grid-cell network are referred to, hereafter, as “grid wells”. Grid wells in SESJ were numbered in the order of sample collection, with the prefix varying by study area: the Kings study area (KING), the Kaweah study area (KWH), the Tule study area (TULE), and the Tulare Lake study area (TLR) ([fig. 4](#)).

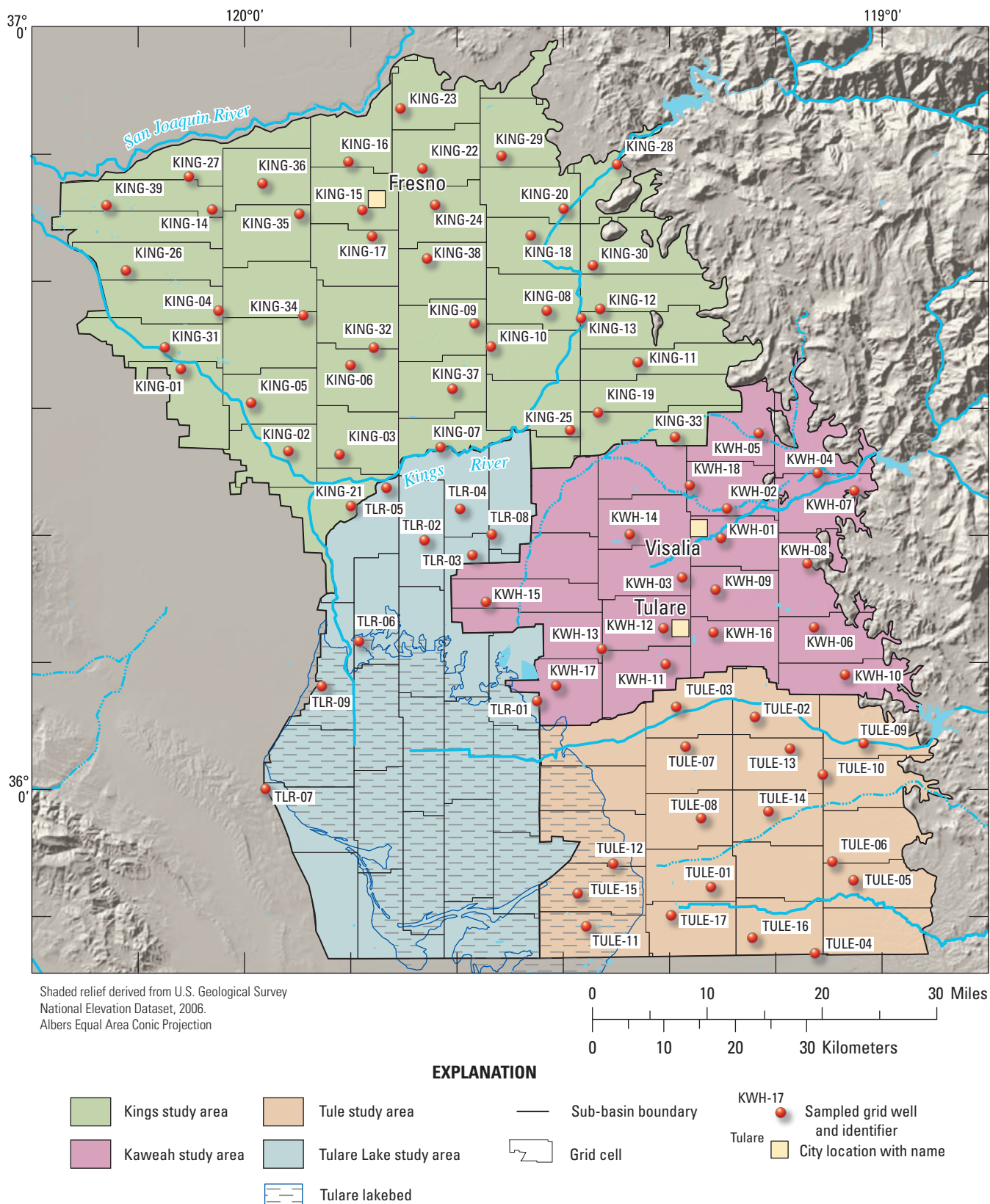


Figure 4. The four study areas, the distribution of grid cells used for randomized well selection, and grid wells sampled in the Southeast San Joaquin Groundwater Ambient Monitoring and Assessment (GAMA) study unit, California.

Of the 83 grid wells sampled, 39 were in the King study area (34 public-supply wells and 5 irrigation wells), 18 were in the Kaweah study area (16 public-supply wells, 1 irrigation well, and 1 domestic well), 17 were in the Tule study area (13 public-supply wells, 3 irrigation wells, and 1 domestic well), and 9 were in the Tulare study area (8 public-supply wells and 1 irrigation well) ([table 1](#); all tables shown in back of report).

Well locations and identifications were verified using a Global Positioning System (GPS), 1:24,000-scale USGS topographic maps, comparison with existing well information in USGS and CDPH databases, and information provided by well owners. Driller's logs for wells were obtained when available. Well information was recorded by hand on field sheets and electronically using specialized software on field laptop computers. All information was verified and then uploaded into the USGS National Water Information System (NWIS). In order to maintain confidentiality of well owners and well locations, the standard USGS protocol for identifying sites in NWIS with a site-id containing latitude and longitude was modified and all data associated with the sites were made inaccessible to the public.

Wells in SESJ were sampled using a tiered analytical approach. All wells were sampled for a standard set of constituents which is the basis of the grid-well analytical design. The standard set of constituents included dissolved oxygen, temperature, and specific conductance, VOCs, 1,2-dibromo-3-chloropropane (DBCP) and 1,2-dibromoethane (EDB), pesticides and pesticide degradates, perchlorate, stable isotopes of water, and dissolved noble gases and tritium/helium age dates. The standard set of constituents was termed the “*fast*” schedule ([table 2](#)). Wells on the “*intermediate*” schedule were sampled for all the constituents on the *fast* schedule, plus pH, alkalinity, polar pesticides and degradates, *N*-nitrosodimethylamine (NDMA), 1,2,3-trichloropropane (1,2,3-TCP), nutrients, major and minor ions and trace elements, chromium abundance and speciation, arsenic and iron abundances and speciation, stable isotopes of nitrogen and oxygen of nitrate, uranium isotopes, and tritium. Wells on the “*slow*” schedule were sampled for all the constituents on the *intermediate* schedule, plus turbidity, gasoline oxygenates and degradates, dissolved organic carbon, stable isotopes of carbon, carbon-14 abundance, and radioactive and microbial constituents ([table 2](#)). *Fast*, *intermediate*, or *slow* refers to the time required to sample the well for all the analytes on the schedule, and not which groups of constituents are included in each schedule. The *intermediate* and *slow* schedules were used for wells sampled for better understanding of a specific topic or served the dual purpose of the grid-well network and for special topics. Fifty-five wells were sampled on the *fast* schedule, 20 wells were sampled on the *intermediate* schedule, and 24 wells were sampled on the *slow* schedule. Understanding wells that were monitoring wells were sampled on the *slow* schedule except for the microbial constituents.

Additional sampling was done to assess changes in water chemistry (1) along selected sub-regional ground-water

flow-paths, (2) from shallow to deeper depths in the aquifer, or (3) along a transect across alluvial fans radiating from the Sierra Nevada. This assessment was accomplished by either sampling grid wells for additional constituents and (or) by sampling additional wells (understanding wells) for two flow-path studies (Kings study area flow-path and Kings River flow-path) and a transect study across alluvial fans (Highway 99 transect).

The Kings study area flow-path study followed the ground-water flow from where the Kings River enters the basin and moves westward away from the Kings River and toward Fresno ([fig. 5](#)). Fifteen additional understanding wells (4 public-supply wells, 11 monitoring wells) and three grid wells in the Kings study area were sampled using the *slow* schedule of constituents to evaluate changes in water quality from shallow to deeper depths in the aquifer along this flow-path. The Kings River flow-path followed the flow of ground water southwesterly along the Kings River ([fig. 5](#)). Ten grid wells were sampled using the *intermediate* schedule for this assessment. The Highway 99 transect followed Highway 99 and includes wells in the various alluvial fans and inter-fan areas located in the SESJ study unit ([fig. 5](#)). Fourteen grid wells in Kings, Kaweah, and Tule study areas and one additional public supply well in the Kings study area were sampled for this study using the *intermediate* schedule of constituents.

Fifteen additional (understanding) wells sampled in the Kings study area for the Kings study area flow-path study were numbered in the order of sample collection with the prefix “KINGFP”; the additional understanding well for the Highway 99 transect was numbered in the order of sample collection with the prefix “HWY99T”. The additional understanding wells sampled as part of these studies were excluded from the overall statistical characterization of water quality in the SESJ study unit, as the inclusion of these wells would have caused overrepresentation of certain grid cells

The GAMA identification number for each of the 99 sampled wells, along with the date sampled, sampling schedule, and well-construction information is provided on [table 1](#). Ground-water samples were collected October 2005 through February 2006.

Sample Collection and Analysis

Samples were collected in accordance with the protocols established by the USGS National Water Quality Assessment (NAWQA) program (Koterba and others, 1995) and the USGS National Field Manual (U.S. Geological Survey, variously dated). These sampling protocols ensure that a representative sample of ground water is collected at each site and that the samples are collected and handled in a way that minimizes the potential for contamination of samples and (or) cross contamination between samples collected at wells. The methods used for sample collection are described in the [Appendix](#).

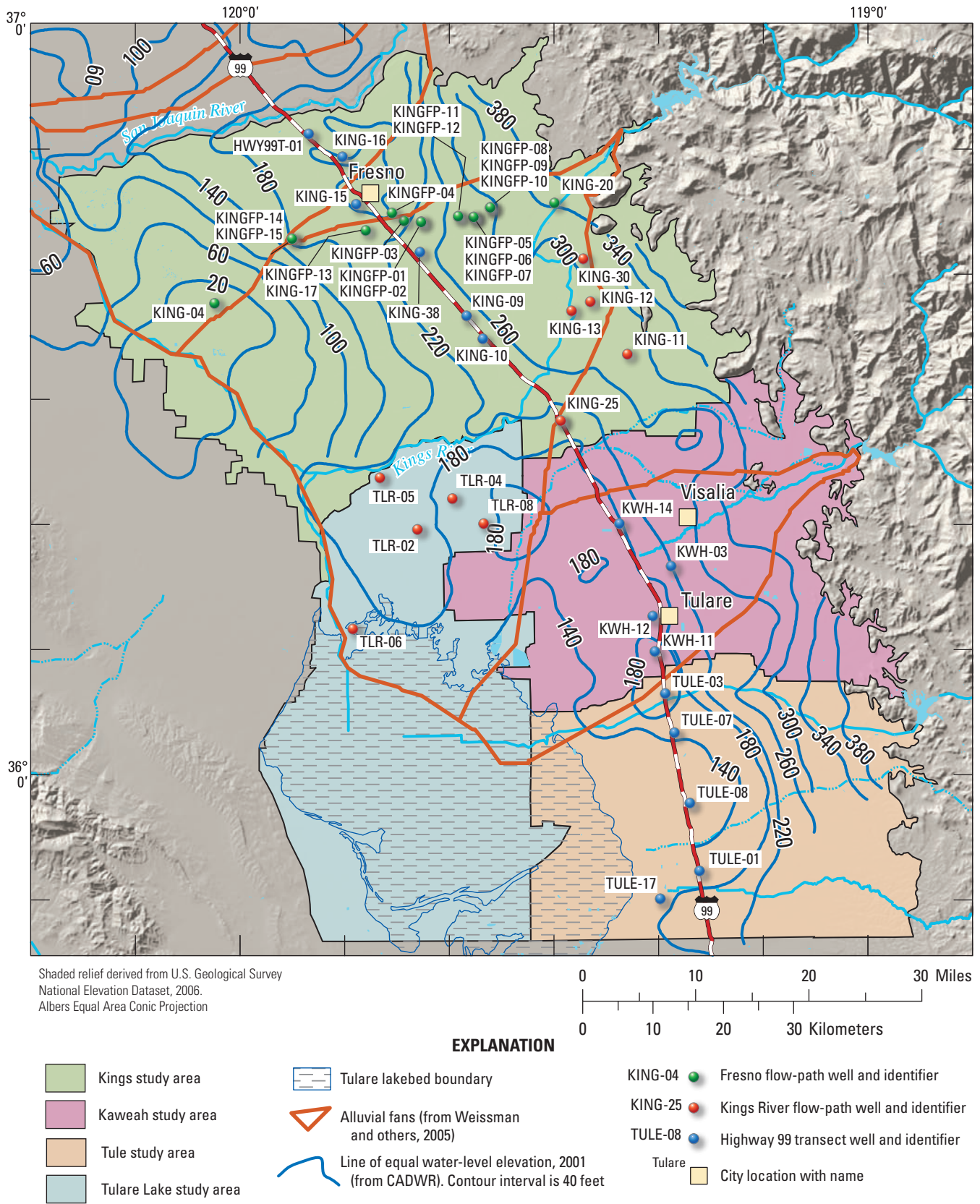


Figure 5. The locations of flow-path and transect wells, water-level contours, alluvial fans, and Tulare lakebed in the Southeast San Joaquin study unit, California.

For this study, raw (untreated) ground-water samples were analyzed for VOCs ([table 3A](#)), gasoline additives ([table 3B](#)), fumigants (DBCP and EDB) ([table 3C](#)), pesticides and pesticide degradates ([table 3D](#)), polar pesticides and pesticide degradates ([table 3E](#)), constituents of special interest (NDMA, 1,2,3-TCP, and perchlorate) ([table 3F](#)), nutrients and dissolved organic carbon (DOC) ([table 3G](#)), major and minor ions and trace elements ([table 3H](#)), arsenic, chromium, and iron species ([table 3I](#)), isotopic and radioactive constituents ([table 3J](#)), noble gases ([table 3K](#)), and the microbial constituents (coliform and coliphage) ([table 3L](#)). General water-quality indicators that were determined in the field included pH, specific conductance (SC), dissolved oxygen (DO), temperature, alkalinity, and turbidity.

Data Reporting

The methods and conventions used for reporting the data are described in the [Appendix](#). Twelve constituents analyzed in this study were measured by more than one method at the USGS National Water Quality Laboratory (NWQL); only the results from the preferred method are reported. Arsenic, iron, and 1,2,3-TCP concentrations and tritium activities were measured by more than one laboratory; both sets of results are reported.

Quality-Assurance and Quality-Control

The quality-assurance (QA) plan used for this study follows the protocols described in the NWQL QA plan (Pirkey and Glodt, 1998; Maloney, 2005) and the protocols used by the USGS NAWQA program (Koterba and others, 1995). Quality-control (QC) samples collected in SESJ include source-solution blanks, field blanks, replicates, and matrix and surrogate spikes. QC samples were collected to evaluate bias and variability of the water chemistry data that may have resulted from sample collection, processing, storage, transportation, and laboratory analysis. The QA plan and results are described in the [Appendix](#).

Ground-Water-Quality Results

The results of analyses of quality-control and ground-water samples are described briefly in the sections below. Thresholds compared to concentrations in ground-water samples also are described.

Quality-Control-Sample Results

Results of QC analyses (blanks, replicates, matrix spikes, and surrogates) were used to evaluate the quality of the data for the ground-water samples. Assessment of the quality-control information from blanks resulted in the censoring of

less than one percent of the detections of VOC, pesticides, nutrients, major and minor ions, and trace elements measured in ground-water samples. Censored data are indicated with “V” codes in [tables 4–15](#), and the censored data are not used in assessments of water quality. Data from replicates indicated that variability between measurements was acceptably low, confirming that the procedures used to collect the samples were consistent. Matrix spike recoveries for 58 of 231 organic constituents were lower than the acceptable limits, which may indicate that these constituents might not have been detected in some samples if they were present at very low concentrations. Ten of these 58 constituents were detected in ground-water samples. Surrogate recoveries were all within acceptable limits for the analyses that use surrogates. The QC results are described in the [Appendix](#).

Comparison with Regulatory and Health-Based Thresholds

Concentrations in ground-water samples were compared with CDPH and USEPA drinking-water regulatory and health-based thresholds and thresholds established for aesthetic purposes (U.S. Environmental Protection Agency, 2006; California Department of Public Health, 2007a) as a way to give context to the detected concentrations. The chemical and microbial data presented in this report are meant to characterize the quality of the untreated ground-water resources within SESJ and in no way are intended to represent the treated drinking water delivered to consumers by water purveyors. The chemical and microbial composition of treated drinking water may differ from untreated ground water because treated drinking water may be subjected to disinfection, filtration, and blending with other waters prior to its delivery to consumers.

The following thresholds are used for comparisons:

- **MCLs—Maximum Contaminant Level.** Legally enforceable standards that apply to public-water systems and are designed to protect public health by limiting the levels of contaminants in drinking water. MCLs established by the USEPA are the minimum standards with which states are required to comply, and individual states may choose to set more stringent standards. CDPH has established MCLs for additional constituents not regulated by the USEPA and has lowered the threshold concentration for a number of constituents with MCLs established by the USEPA. In this report, a threshold set by the USEPA and adopted by CDPH is labeled “MCL-US”, and one set by CDPH that is more stringent than the MCL-US is labeled “MCL-CA”. CDPH is notified when constituents are detected at concentrations exceeding MCL-US or MCL-CA thresholds in samples collected for the GAMA Statewide Basin Assessment project.
- **SMCLs—Secondary Maximum Contaminant Level.** Non-enforceable standards applied to constituents that

affect the aesthetic qualities of drinking water, such as taste, odor, and color. Both the USEPA and CDPH define SMCLs, but unlike MCLs, SMCLs established by CDPH are not required to be at least as stringent as those established by USEPA. SMCLs established by CDPH are used in this report (SMCL-CA) for all constituents that have SMCL-CA values. The SMCL-US is used for pH because no SMCL-CA has been defined.

- **HAL—Lifetime Health Advisory Level.** The maximum concentration of a constituent at which its presence in drinking water is not expected to cause any adverse carcinogenic effects for a lifetime of exposure. HALs are established by the USEPA (HAL) and are calculated assuming consumption of 2 liters of water per day over a 70-year lifetime by a 70-kilogram adult and that 20 percent of a person’s exposure comes from drinking water.
- **AL—Action Level.** Legally enforceable standards that apply to public water systems and are designed to protect public health by limiting the levels of copper and lead in drinking water. Detections of copper or lead above thresholds trigger requirements for mandatory water treatment to reduce the corrosiveness of water to water pipes. The action levels established by the USEPA and CDPH are the same, thus the thresholds are labeled “AL” in this report.
- **RSD5—Risk-Specific Dose.** The concentration of a constituent in drinking water corresponding to an excess estimated lifetime cancer risk of 1 in 100,000. RSD5 is an acronym for risk-specific dose at 10^{-5} . RSD5s are calculated by dividing the 10^{-4} cancer risk concentration established by the USEPA by 10 (RSD5).
- **NL—Notification Level.** Health-based notification levels established by CDPH for some of the constituents in drinking water that lack MCLs (NL-CA). If a constituent is detected above its NL-CA, State law requires timely notification of local governing bodies and recommends consumer notification.
- **TT—Treatment Technique.** Legally enforceable standards that apply to public-water systems and are designed to protect public health by limiting the levels of copper, lead, and microbial constituents in drinking water. TT requirements are applied when water delivered to consumers exceeds specified action levels. Detections of copper or lead above thresholds trigger requirements for mandatory water treatment to reduce the corrosiveness of water to water pipes. Detections of microbial constituents above thresholds trigger requirements for mandatory additional disinfection during water treatment. The action levels established by the USEPA and CDPH are the same, thus these thresholds are labeled “TT-US” in this report

For constituents with MCLs, detections in ground-water samples were compared to the MCL-US or MCL-CA. Constituents with SMCLs were compared with the SMCL-CA. For chloride, sulfate, and total dissolved solids, CDPH defines a “recommended” and an “upper” SMCL-CA; detections of these constituents in ground-water samples are compared with both levels. The SMCL-US for these constituents corresponds to the recommended SMCL-CA. Detected concentrations of constituents that lack MCLs and SMCLs were compared to NL-CAs. For constituents that lack an MCL, SMCL, or NL-CA, detected concentrations were compared with the HAL. For constituents that lack an MCL, SMCL, NL-CA, or HAL, detected concentrations were compared with the RSD5. Note that this hierarchy of selection of comparison thresholds means that for constituents that have multiple types of established thresholds, the threshold used for comparison purposes may not be the one with the lowest concentration. The comparison thresholds used in this report are listed in [tables 3A–L](#) for all constituents and in [tables 4–15](#) for constituents detected in ground-water samples from SESJ. Detections of constituents at concentrations greater than the comparison threshold are marked with an asterisk.

Water-Quality Data

Results from the analyses of raw (untreated) ground-water for the SESJ study are presented in [tables 4–15](#). Ground-water samples collected in SESJ were analyzed for more than 300 constituents ([tables 3A–L](#)); 172 of those constituents were not detected in any of the samples. The tables present only the constituents that were detected, and list only samples that had at least one constituent detected. For constituent classes that were analyzed at all of the grid wells, the tables include the number of wells at which each analyte was detected, the frequency at which it was detected (in relation to the number of grid wells), and the total number of constituents detected at each well. Results from the understanding wells are presented in the tables, but these results were excluded from the detection frequency calculations to avoid statistically over-representing the areas in the vicinity of the flow-paths.

[Table 4](#) includes water-quality indicators measured in the field and at NWQL, while [tables 5–15](#) present the results of ground-water analyses organized by the compound types and classes:

- Organic constituents
 - VOCs and gasoline oxygenates ([table 5](#))
 - Pesticides and pesticide degradates ([table 6A](#))
 - Polar pesticides and (or) pesticide degradates and caffeine ([table 6B](#))
- Constituents of special interest ([table 7](#))
- Inorganic constituents
 - Nutrients and dissolved organic carbon ([table 8](#))
 - Major and minor ions ([table 9](#))
 - Trace elements ([table 10](#))

- Arsenic and iron species ([table 11](#))
- Radioactive constituents ([table 12](#))
- Microbial indicators ([table 13](#))
- Tracer constituents
 - Stable isotopes of oxygen and hydrogen in water and oxygen and nitrogen in nitrate ([table 14](#))
 - Noble gases, helium isotopes, and tritium ([table 15](#))

Field Parameters

Field and laboratory measurements of dissolved oxygen, pH, specific conductance, alkalinity, turbidity, water temperature and associated parameters are presented in [table 4](#). Dissolved oxygen and alkalinity are used as indicators of natural processes that control water chemistry. Specific conductance is the unit electrical conductivity of the water and is proportional to amount of dissolved salts in the water. The pH value indicates the acidity or basicity of the water. Eleven of the 83 grid wells had specific conductance values above the recommended SMCL-CA, but only one well also was above the upper threshold. Eight grid wells had field-measured pH values outside of the SMCL-US range for pH.

Organic Constituents

Volatile Organic Compounds and Gasoline Additives

Volatile organic compounds (VOCs) are present in paints, solvents, fuels, fuel additives, refrigerants, fumigants, and disinfected water and are characterized by their tendency to evaporate. VOCs generally persist longer in ground water than in surface water because ground water is isolated from the atmosphere. Fifty-nine of the 88 VOCs analyzed were not detected in any samples. Approximately 60 percent of the 83 grid wells sampled had at least one detection of a VOC ([table 5](#)). Four VOCs were detected in more than 10 percent of the wells: chloroform (a disinfection by-product), DBCP (a soil fumigant and nematocide), tetrachloroethene (PCE, a solvent used for dry-cleaning), and *m*- and *o*-xylenes (gasoline component, solvent). Two VOCs were detected above a regulatory threshold: DBCP and benzene. Benzene (gasoline component, organic synthesis) was detected at a level almost 80 times its MCL in one well. This concentration is similar to what has been detected historically. The water is treated to reduce benzene concentrations before it enters the public supply system. Most of the other VOCs detected were at concentrations one-tenth to less than one-hundredth of the threshold value.

Pesticides

Pesticides include herbicides, insecticides, and fungicides and are used to control weeds, insects, fungi, and other pests in agricultural, urban, and suburban settings. All detections of pesticides or pesticide degradates that had health-based thresholds in samples from SESJ were below these thresholds,

and almost all were less than one-hundredth of the threshold values ([tables 6A, 6B](#)). More than half of the grid wells sampled had at least one pesticide detection. Seven pesticides were detected in more the 10 percent of the grid wells sampled. Five of these (simazine, deethylatrazine, atrazine, prometon, and bromacil) are among the most commonly detected pesticides in ground water nationally (Gilliom and others, 2006).

Caffeine was detected in 36 percent of the 28 grid wells sampled for polar pesticides. Caffeine, which is not a registered pesticide, is included on the polar pesticide class of constituents because its molecular structure allows it to be detected using the same analytical methods as the polar pesticides.

Constituents of Special Interest

Perchlorate, NDMA, and 1,2,3-TCP are constituents of special interest in California because they recently have been found in water supplies (California Department of Public Health, 2007b). Perchlorate was detected in 19 percent of the grid wells, but only one had a concentration above the MCL-CA ([table 7](#)). NDMA and 1,2,3-TCP were not detected above their thresholds.

Inorganic Constituents

Unlike the organic constituents and the constituents of special interest, most of the inorganic constituents are present naturally in ground water, although their concentrations may be influenced by human activities. Forty-four of the 99 SESJ wells were sampled for nutrients, major and minor ions, and trace elements.

The nutrients—nitrogen and phosphorus—and the dissolved organic carbon present in ground water can affect biological activity in aquifers and in surface-water bodies that receive ground-water discharge. Nitrogen may be present in the form of ammonia, nitrite, or nitrate, depending on the oxidation-reduction state of the ground water. High concentrations of nitrate can adversely affect human health, particularly the health of infants. Nitrate was detected in 22 grid wells and 14 understanding wells, with six of the detections above the MCL-US ([table 8](#)). All six of the detections above the MCL-US were in understanding wells, of which only one was a public-supply well. Concentrations of orthophosphate and dissolved organic carbon were low.

The major-ion composition, total dissolved solids (TDS) content, and levels of certain trace elements in ground water affect the aesthetic properties of water such as taste, color, and odor, and the technical properties such as scaling and staining. Although there are no adverse health effects associated with these properties, they may reduce consumer satisfaction with the water or may have economic impacts. CDPH has established non-enforceable thresholds (SMCL-CAs) that are based on aesthetic or technical properties rather than health-

based concerns for the major ions chloride and sulfate, TDS, and a few trace elements.

Sulfate, TDS, (table 9) and manganese (table 10) were detected above recommended threshold values. Samples from one grid well and six understanding wells had concentrations of TDS above the recommended SMCL-CA, of which one was greater than the upper threshold. This sample was not from a public supply well. Samples from two wells had sulfate concentrations greater than the recommended SMCL-CA. Manganese was detected above its SMCL-CA in one grid well and two understanding wells. Manganese is a trace element whose concentration is affected by the oxidation-reduction state of the ground water. Precipitation of minerals containing manganese may cause orange or black staining of surfaces.

Eighteen of the 25 trace elements analyzed in this study have health-based thresholds; 2 trace elements have SMCL-CAs; 2 trace elements have NL-CAs. Of the 23 trace elements detected (table 10), 4 were detected at concentrations above established health-based thresholds. Arsenic and uranium were detected above their MCLs. Boron and vanadium were detected above their NL-CAs.

Arsenic, iron, and chromium occur in different species depending on the oxidation-reduction state of the ground water. The oxidized and reduced species have different solubilities in ground water and may have different effects on human health. The relative proportions of the oxidized and reduced species of each element also are used to aid in interpretation of the oxidation–reduction state of the aquifer. Concentrations of arsenic and iron and the concentrations of either the reduced or oxidized species of each element are reported on table 11. The concentration of the other species can be calculated by difference. The concentrations of arsenic and iron reported in table 11 may be different than those reported in table 10 because different analytical methods were used (see Appendix). The concentrations reported in table 10 are considered to be more accurate. Chromium species are not shown in the table because of suspected contamination of samples during the preservation process.

Radioactive Constituents

Radioactivity is the release of energy or energetic particles during changes in the structure of the nucleus of an atom. Most of the radioactivity in ground water comes from decay of naturally occurring isotopes of uranium and thorium that are present within minerals in the saturated sediments or fractured rocks. Both uranium and thorium decay in a series of steps, eventually forming stable isotopes of lead. Radium-226, radium-228, and radon-222 are radioactive isotopes formed during the uranium and thorium decay series. In each step in the decay series, one radioactive element turns into a different radioactive element by emitting an alpha or a beta particle from its nucleus. For example, radium-226 emits an alpha particle, and thus, turns into radon-222. Radium-228 decays to form actinium-228 by emission of a beta particle. The alpha and beta particles emitted during radioactive decay are

hazardous to human health because these energetic particles may damage cells. Radiation damage to cell DNA may increase the risk of getting cancer.

Activity often is used instead of concentration for reporting the presence of radioactive constituents. Activity of radioactive constituents in ground water is measured in units of picocuries per liter (pCi/L), and one picocurie is approximately equal to two atoms decaying per minute. The number of atoms decaying is equal to the number of alpha or beta particles emitted.

In nature, uranium atoms exist as uranium-238 (99.275 percent), uranium-235 (0.711 percent), and a very small amount of uranium-234 (0.0058 percent). Natural uranium only is weakly radioactive. Scientists have never detected cancer caused by radiation from low levels of natural uranium. However, exposure to some of uranium's decay products, especially radon, can pose a significant health threat (Agency for Toxic Substances and Disease Registry, 1999). Uranium isotope activities were detected above the MCL-CA for uranium-234 and -238 in 1 well of the 44 that were sampled (table 12). This well was an understanding well and was not used for public supply.

The activity of 72-hour counts of gross alpha radiation were above the MCL-US in 5 of the 24 wells sampled for radioactive constituents; one of these wells was a grid well, and the remaining four were understanding wells. Two wells were above the MCL-US for 30-day counts of gross alpha radiation; one of these was a grid well. Activities of gross beta radiation and radium all were less than the established health-based standards (table 13). The activities of radon-222 in all samples collected were above the proposed MCL-US of 300 pCi/L, however, no samples had an activity that also was above the proposed alternative MCL-US of 4,000 pCi/L. The alternative MCL-US will apply if the State or local water agency has an approved multimedia mitigation program to address radon in indoor air (U.S. Environmental Protection Agency, 1999a).

Microbial Constituents

Water is disinfected during drinking-water treatment to prevent diseases that may be spread by water-borne microbial constituents derived from human or animal wastes. The specific viruses and bacteria responsible for diseases generally are not measured because routine analytical methods are not available. Measurements are made of more easily analyzed microbial constituents that serve as indicators of the presence of human or animal waste in water. Coliforms and coliphage are used as indicator organisms for water-borne pathogens. Coliforms indicate that the potential for bacterial contamination and coliphage are viruses that infect coliform bacteria and are indicators for fecal contamination in the well as well as represent the potential survival and transport of viruses. Drinking water purveyors respond to detections of microbial indicators by applying additional disinfection to the water.

Two grid wells of the nine grid and understanding wells sampled for microbial constituents had total coliforms above the MCL-US, however, *Escherichia coli*, an indicator of fecal contamination, was not detected (table 13). Somatic coliphage was detected in one grid well, but not the F-specific coliphage, which comes from warm-blooded animals or sewage.

Tracer Constituents

Stable isotope ratios, tritium and carbon-14 activities, and noble gas concentrations can be used as tracers of natural processes affecting ground-water composition. Hydrogen and oxygen stable isotope ratios of water can be used to aid in interpretation of ground-water recharge sources. The stable isotope ratios of water (table 14) depend on the altitude, latitude, and temperature of precipitation and on the extent of evaporation of surface or soil water. Nitrogen and oxygen stable isotope ratios of nitrate can be used to aid in interpretation of sources and processes affecting nitrate concentrations (table 14). Carbon-14 (table 12) is a radioactive isotope of carbon that is incorporated into dissolved carbonate species in water. Low levels of carbon-14 are produced continuously by cosmic ray bombardment of nitrogen in the atmosphere. Because carbon-14 decays with a half-life of approximately 5,700 years, low activities of carbon-14, relative to modern values, generally indicate presence of ground water that is several thousand years old.

Tritium activities (tables 12 and 15), carbon-14 activities (table 12), and helium isotope ratios (table 15) can provide information about the time since the water entered the ground-water system (ground-water age). Tritium is a radioactive isotope of hydrogen that is incorporated into the water molecule. Low levels of tritium are produced continuously by cosmic ray bombardment of water in the atmosphere, and a large amount of tritium was produced by atmospheric testing of nuclear weapons between 1952 and 1963. Thus, concentrations of tritium above background generally indicate the presence of water recharged since the early 1950's. Helium isotope ratios (table 15) can be used in conjunction with tritium concentrations to estimate more exact ages for young ground water. Noble gas concentrations (table 15) can be used to aid in interpretation of ground-water recharge sources because the concentrations of the different noble gases depend on water temperature.

Of the tracer constituents analyzed for this study, the only one with a health-based threshold is tritium. All measured tritium activities were less than one-thousandth of the MCL-CA.

Future Work

Subsequent reports will be focused on assessment of the data presented in this report using a variety of statistical, qualitative, and quantitative approaches to assess the natural

and human factors affecting ground-water quality. Water-quality data contained in the CDPH and USGS-NWIS databases and other water-quality data available from State and local water agencies will be compiled, evaluated, and used to complement the data presented in this report.

Summary

Ground-water quality in the approximately 3,800-mi² (9,700-km²) Southeast San Joaquin (SESJ) study unit was investigated from October 2005 through February 2006 as part of the Priority Basin Assessment Project of Ground-Water Ambient Monitoring and Assessment (GAMA) Program. The GAMA Priority Basin Assessment project was developed in response to the Ground-Water Quality Monitoring Act of 2001 Survey (<http://www.swrcb.ca.gov/gama/>; Belitz and others, 2003); and is being implemented by the California State Water Resources Control Board in collaboration with the U.S. Geological Survey and Lawrence-Livermore National Laboratory. The project is a comprehensive assessment of statewide ground-water quality designed to help identify and characterize risks to ground-water resources, and to increase the availability of information about ground-water quality to the public. SESJ was the seventh study unit sampled as part of the project.

SESJ is in the southeast portion of the San Joaquin Valley in the Central Valley hydrogeologic province. The study unit includes four ground-water subbasins, as defined by the California Department of Water Resources (California Department of Water Resources, 2003). SESJ included assessment of the ground-water quality from 99 wells in Fresno, Tulare, and Kings Counties. Eighty-three of the wells were selected using a spatially distributed, randomized grid-based method to achieve a statistically unbiased representation of ground water used for public drinking-water supplies ("grid wells"). Sixteen additional wells ("understanding wells") were selected to provide additional sampling density to aid in the understanding of processes affecting ground-water quality. Ground-water samples were analyzed for VOCs, pesticides and pesticide degradates, pharmaceutical compounds, nutrients, major and minor ions, trace elements, radioactivity, and microbial indicators. Naturally occurring isotopes (stable isotopes of hydrogen, oxygen, nitrogen, and carbon, and activities of tritium and carbon-14) and dissolved noble gases also were measured to provide a data set that can be used in the interpretation of the source and age of the sampled ground water. This report describes the hydrogeologic setting of the SESJ region; details the sampling, analytical, and quality-assurance methods used in the study; and presents the results of the chemical and microbial analyses made of the ground-water samples collected October 2005 through February 2006.

Quality-control samples (blanks, replicates, samples for matrix spikes) were collected from about 10 percent of the wells, and the results for these samples were used to evaluate the quality of the data for the ground-water samples. In addition, surrogates were added to all VOC and pesticide samples. Assessment of the quality-control data showed that the sample data were of good quality (low bias and low variability), and resulted in censoring of less than 1 percent of the ground-water-quality data.

This study did not attempt to evaluate the quality of water delivered to consumers; after withdrawal from the ground, water typically is treated, disinfected, and (or) blended with other waters to maintain acceptable water quality. Regulatory thresholds apply to treated water that is served to the consumer, not to raw ground water. However, to provide some context for the results, concentrations of constituents measured in the raw ground water were compared with health-based thresholds established by the U.S. Environmental Protection Agency (USEPA) and California Department of Public Health (CDPH).

Fifty-nine of the 88 VOCs analyzed were not detected. Of the VOCs detected, most were detected at concentrations one-tenth to less than one-hundredth of the health-based threshold value for those compounds that had health-based thresholds. Two VOCs were detected above a regulatory threshold: DBCP and benzene. All detections of pesticides or pesticide degradates that had health-based thresholds were below their thresholds, and most were less than one-hundredth of the threshold values. Nitrate was detected above its maximum contaminant level (MCL) in six understanding well samples of which one was a public supply well. Two trace elements were detected above MCLs: arsenic and uranium. Perchlorate was detected above its MCL-CA in one grid well. Gross alpha radiation activities were detected above their MCL in one grid well and four understanding wells. Uranium isotope activity was greater than the MCL for one understanding well. Radon-222 was detected above the proposed MCL-US of 300 pCi/L in all wells sampled, but none were above the proposed alternative MCL-US of 4,000 pCi/L. Total coliforms were detected in two grid wells and somatic coliphage was detected in one grid well. Total dissolved solids, specific conductance, sulfate, and manganese were detected above their SMCL-CAs, and pH was detected above its SMCL-US, non-enforceable thresholds for aesthetic concerns, in samples from several of the grid and understanding wells. NDMA, boron, and vanadium were detected above their respective NL-CAs. Future work will evaluate the data presented in this report using a variety of statistical, qualitative, and quantitative approaches to assess the natural and human factors affecting ground-water quality.

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Tables

Table 1. Identification, sampling, and construction information for wells sampled for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.

[King, Kings study area well; KWH, Kaweah study area well; TULE, Tule study area well; TLR, Tulare Lake study area well; KINGFP, Kings study area flow-path wells; HWY99T, Highway 99 transect well; MW, monitoring well; LSD, land-surface datum; ft, foot; nd, no data]

GAMA identification number	Sampling information		Elevation of LSD (ft above NAVD88) ²	Construction information		
	Date (mm/dd/yyyy)	Sampling schedule ¹		Well depth (ft below LSD)	Top perforation (ft below LSD)	Bottom perforation (ft below LSD)
Kings Grid Wells						
KING-01	10/17/2005	Fast	185	610	580	600
KING-02	10/17/2005	Fast	208	nd	nd	nd
KING-03	10/17/2005	Fast	225	380	145	358
KING-04	10/17/2005	Slow	200	500	240	500
KING-05	10/18/2005	Fast	201	555	505	545
KING-06	10/18/2005	Fast	246	705	345	695
KING-07	10/18/2005	Fast	256	410	194	410
KING-08	10/19/2005	Fast	341	540	287	540
KING-09	10/19/2005	Intermediate	314	582	202	380
KING-10	10/19/2005	Intermediate	308	228	228	open bottom
KING-11	10/20/2005	Intermediate	340	540	280	520
KING-12	10/20/2005	Intermediate	354	246	126	246
KING-13	10/20/2005	Intermediate	315	420	260	400
KING-14	10/24/2005	Fast	224	800	640	780
KING-15	10/25/2005	Intermediate	282	440	270	440
KING-16	10/25/2005	Intermediate	305	nd	nd	nd
KING-17	10/26/2005	Slow	280	650	320	640
KING-18	10/26/2005	Fast	370	370	160	360
KING-19	10/27/2005	Fast	300	260	218	260
KING-20	10/27/2005	Slow	393	124	nd	nd
KING-21	10/27/2005	Fast	228	210	150	210
KING-22	11/1/2005	Fast	338	510	280	500
KING-23	11/1/2005	Fast	362	540	150	510
KING-24	11/1/2005	Fast	325	236	140	236
KING-25	11/2/2005	Intermediate	288	384	168	384
KING-26	11/2/2005	Fast	174	480	240	480
KING-27	11/2/2005	Fast	228	409	nd	nd
KING-28	11/3/2005	Fast	485	76	40	74
KING-29	11/3/2005	Fast	388	390	120	390
KING-30	11/3/2005	Intermediate	383	490	330	470
KING-31	11/14/2005	Fast	173	520	280	520
KING-32	11/14/2005	Fast	257	445	370	445
KING-33	11/17/2005	Fast	315	675	175	655
KING-34	11/28/2005	Fast	232	nd	nd	nd
KING-35	12/1/2005	Fast	256	nd	nd	nd
KING-36	12/8/2005	Fast	258	452	nd	nd
KING-37	12/14/2005	Fast	274	nd	nd	nd
KING-38	12/15/2005	Intermediate	305	700	nd	nd
KING-39	12/15/2005	Fast	176	nd	nd	nd

Table 1. Identification, sampling, and construction information for wells sampled for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.—Continued

[King, Kings study area well; KWH, Kaweah study area well; TULE, Tule study area well; TLR, Tulare Lake study area well; KINGFP, Kings study area flow-path wells; HWY99T, Highway 99 transect well; MW, monitoring well; LSD, land-surface datum; ft, foot; nd, no data]

GAMA identification number	Sampling information		Elevation of LSD (ft above NAVD88) ²	Construction information		
	Date (mm/dd/yyyy)	Sampling schedule ¹		Well depth (ft below LSD)	Top perforation (ft below LSD)	Bottom perforation (ft below LSD)
Kaweah Grid Wells						
KWH-01	10/31/2005	Fast	348	640	245	620
KWH-02	10/31/2005	Fast	356	225	116	225
KWH-03	10/31/2005	Intermediate	318	310	nd	nd
KWH-04	11/15/2005		Fast	430	205	80
KWH-05	11/15/2005	Fast	373	nd	nd	nd
KWH-06	11/15/2005	Intermediate	371	580	300	580
KWH-07	11/16/2005	Fast	488	nd	nd	nd
KWH-08	11/16/2005	Fast	413	nd	nd	nd
KWH-09	11/16/2005	Fast	327	nd	nd	nd
KWH-10	11/17/2005	Fast	410	323	nd	nd
KWH-11	11/17/2005	Intermediate	270	700	300	700
KWH-12	11/28/2005	Slow	288	404	205	381
KWH-13	11/30/2005	Fast	254	220	nd	nd
KWH-14	11/30/2005	Slow	295	400	175	390
KWH-15	12/1/2005	Fast	229	nd	nd	nd
KWH-16	12/7/2005	Fast	306	240	200	240
KWH-17	12/13/2005	Fast	226	350	225	338
KWH-18	12/13/2005	Fast	328	165	95	155
Tule Grid Wells						
TULE-01	11/29/2005	Slow	286	800	400	800
TULE-02	11/30/2005	Fast	338	nd	nd	nd
TULE-03	11/30/2005	Intermediate	266	280	169	270
TULE-04	12/5/2005		Fast	515	820	550
TULE-05	12/5/2005	Fast	577	1368	930	1348
TULE-06	12/5/2005	Fast	486	1641	702	1641
TULE-07	12/6/2005	Intermediate	276	600	nd	nd
TULE-08	12/7/2005		Slow	272	810	340
TULE-09	12/7/2005	Fast	450	587	160	587
TULE-10	12/7/2005	Fast	403	965	201	965
TULE-11	12/8/2005	Fast	212	1150	600	1150
TULE-12	12/8/2005	Fast	206	nd	nd	nd
TULE-13	12/13/2005	Fast	379	400	120	400
TULE-14	12/13/2005	Fast	250	600	280	600
TULE-15	12/14/2005	Fast	213	1330	970	1265
TULE-16	12/14/2005	Fast	357	nd	nd	nd
TULE-17	2/28/2006	Intermediate	243	245	185	240

Table 1. Identification, sampling, and construction information for wells sampled for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.—Continued

[King, Kings study area well; KWH, Kaweah study area well; TULE, Tule study area well; TLR, Tulare Lake study area well; KINGFP, Kings study area flow-path wells; HWY99T, Highway 99 transect well; MW, monitoring well; LSD, land-surface datum; ft, foot; nd, no data]

GAMA identification number	Sampling information		Elevation of LSD (ft above NAVD88) ²	Construction information		
	Date (mm/dd/yyyy)	Sampling schedule ¹		Well depth (ft below LSD)	Top perforation (ft below LSD)	Bottom perforation (ft below LSD)
Tulare Lake Grid Wells						
TLR-01	11/28/2005	Fast	217	nd	nd	nd
TLR-02	11/29/2005	Intermediate	240	1330	1000	1330
TLR-03	11/29/2005	Fast	246	1420	1067	1395
TLR-04	12/1/2005	Slow	254	1320	980	1300
TLR-05	12/5/2005	Slow	238	561	311	561
TLR-06	12/6/2005	Intermediate	204	nd	nd	nd
TLR-07	12/6/2005	Fast	278	570	210	545
TLR-08	12/12/2005	Intermediate	349	nd	nd	nd
TLR-09	12/14/2005	Fast	197	1200	nd	nd
Understanding Wells						
KINGFP-01	10/18/2005	Slow	310	320	160	310
KINGFP-02	10/19/2005	Slow	307	620	410	610
KINGFP-03	10/20/2005	Slow	301	550	445	540
KINGFP-04	10/25/2005	Slow	295	420	150	240
KINGFP-05	10/31/2005	Slow (MW)	345	172	162	167
KINGFP-06	11/1/2005	Slow (MW)	345	265	255	260
KINGFP-07	11/1/2005	Slow (MW)	345	70	60	65
KINGFP-08	11/2/2005	Slow (MW)	356	81	71	76
KINGFP-09	11/2/2005	Slow (MW)	356	168	158	163
KINGFP-10	11/3/2005	Slow (MW)	356	268	258	263
KINGFP-11	11/14/2005	Slow (MW)	332	158	148	153
KINGFP-12	11/14/2005	Slow (MW)	332	80	70	75
KINGFP-13	11/15/2005	Slow (MW)	281	148	108	138
KINGFP-14	11/16/2005	Slow (MW)	243	140	110	130
KINGFP-15	11/16/2005	Slow (MW)	243	208	178	198
HWY99T-01	10/25/2005	Intermediate	311	681	213	670

¹ Sampling schedules are described in table 2.

² Land-surface datum (LSD) is a datum plane that is approximately at land surface at each well. The elevation of the LSD is described in feet above the North American Vertical Datum 1988.

Table 2. Classes of water-quality indicators, and chemical and microbial constituents collected for the slow, intermediate, and fast sampling schedules in the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.

Analyte classes	Analyte list table	Slow schedule	Intermediate schedule	Fast schedule
Water-quality indicators				
Dissolved oxygen, temperature, specific conductance		X	X	X
pH, alkalinity		X	X	
Turbidity		X		
Organic constituents				
Volatile organic compounds, including DBCP	3A	X	X	X
Gasoline additives and oxygenates	3B	X		
1,2-Dibromo-3-chloropropane (DBCP) and 1,2-Dibromomethane (EDB)	3C	X	X	X
Pesticides and pesticide degradates	3D	X	X	X
Polar pesticides and pesticide degradates	3E	X	X	
Constituents of special interest				
Perchlorate	3F	X	X	X
<i>N</i> -Nitrosodimethylamine (NDMA)	3F	X	X	
1,2,3-Trichloropropane	3F	X	X	
Inorganic constituents				
Nutrients	3G	X	X	
Major and minor ions and trace elements	3H	X	X	
Chromium abundance and speciation	3I	X	X	
Arsenic and iron abundances and speciation	3I	X	X	
Dissolved organic carbon	3G	X		
Stable isotopes				
Stable isotopes of hydrogen and oxygen in water	3J	X	X	X
Stable isotopes of nitrogen and oxygen in nitrate	3J	X	X	
Stable isotopes of carbon and carbon-14 abundance	3J	X		
Radioactivity and gases				
Tritium	3J	X	X	
Tritium and noble gases	3K	X	X	X
Radium isotopes	3J	X		
Radon-222	3J	X		
Gross alpha and beta radiation	3J	X		
Uranium isotopes	3J	X	X	
Microbial constituents				
Microbial constituents	3L	X ¹		

¹ Not collected at monitoring wells.

Table 3A. Volatile organic compounds and gasoline additives, primary uses or sources, comparative thresholds, and reporting information for the USGS National Water Quality Laboratory Schedule 2020.

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property; CAS, Chemical Abstract Service; HAL, U.S. Environmental Protection Agency Lifetime Health Advisory; LRL, Laboratory reporting level; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; NL-CA, California Department of Public Health notification level; RSD5, risk-specific dose at 10^{-5} µg/L; µg/L, micrograms per liter; na, not available; D, detected; —, not detected]

Constituent (synonym or abbreviation)	Primary use or source	USGS parameter code	CAS number	LRL (µg/L)	Threshold type ¹	Threshold value (µg/L)	Detection
Acetone	Solvent	81552	67-64-1	6	na	na	D
Acrylonitrile	Organic synthesis	34215	107-13-1	0.8	RSD5	0.6	—
Benzene	Gasoline	34030	71-43-2	0.021	MCL-CA	1	D
Bromobenzene	Solvent	81555	108-86-1	0.028	na	na	—
Bromochloromethane	Fire retardant	77297	74-97-5	0.12	HAL	90	—
Bromodichloromethane	Disinfection by-product (THM)	32101	75-27-4	0.028	MCL-US	280	D
Bromoform (tribromomethane)	Disinfection by-product (THM)	32104	75-25-2	0.10	MCL-US	280	D
2-Butanone (MEK, methyl ethyl ketone)	Solvent	81595	78-93-3	2	HAL	4,000	D
n-Butylbenzene	Gasoline hydrocarbon	77342	104-51-8	0.12	NL-CA	260	—
sec-Butylbenzene	Gasoline hydrocarbon	77350	135-98-8	0.06	NL-CA	260	—
tert-Butylbenzene	Gasoline hydrocarbon	77353	98-06-6	0.06	NL-CA	260	—
Carbon disulfide	Organic synthesis	77041	75-15-0	0.038	NL-CA	160	D
Carbon tetrachloride (Tetrachloromethane)	Solvent	34506	71-55-6	0.032	MCL-CA	0.5	D
Chlorobenzene	Solvent	34301	108-90-7	0.028	MCL-CA	70	—
Chloroethane	Solvent	34311	75-00-3	0.12	na	na	—
Chloroform (Trichloromethane)	Disinfection by-product (THM)	32106	67-66-3	0.024	MCL-US	280	D
Chloromethane	Refrigerant/organic synthesis	34418	74-87-3	0.17	HAL	30	—
3-Chloro-1-propene	Organic synthesis	78109	107-05-1	0.5	na	na	—
2-Chlorotoluene	Solvent	77275	95-49-8	0.04	HAL	100	—
4-Chlorotoluene	Solvent	77277	106-43-4	0.05	HAL	100	—
Dibromochloromethane	Disinfection by-product (THM)	32105	124-48-1	0.10	MCL-US	280	D
1,2-Dibromo-3-chloropropane (DBCP)	Fumigant	82625	96-12-8	0.51	MCL-US	0.2	D
1,2-Dibromoethane (EDB)	Fumigant	77651	106-93-4	0.036	MCL-US	0.05	—
Dibromomethane	Solvent	30217	74-95-3	0.050	na	na	D
1,2-Dichlorobenzene	Solvent	34536	95-50-1	0.048	MCL-US	600	—
1,3-Dichlorobenzene	Solvent	34566	541-73-1	0.03	HAL	600	—
1,4-Dichlorobenzene	Fumigant	34571	106-46-7	0.034	MCL-CA	5	D
trans-1,4-Dichloro-2-butene	Organic synthesis	73547	110-57-6	0.70	na	na	—
Dichlorodifluoromethane (CFC-12)	Refrigerant	34668	75-71-8	0.18	HAL	1,000	—
1,1-Dichloroethane	Solvent	34496	75-34-3	0.035	MCL-US	5	D
1,2-Dichloroethane	Solvent	32103	107-06-2	0.13	MCL-CA	0.5	—
1,1-Dichloroethene	Organic synthesis	34501	75-35-4	0.024	MCL-CA	6	D
cis-1,2-Dichloroethene	Solvent	77093	156-59-2	0.024	MCL-CA	6	D
trans-1,2-Dichloroethene	Solvent	34546	156-60-5	0.032	MCL-CA	10	—
Dichloromethane (Methylene chloride)	Solvent	34423	75-09-2	0.06	MCL-US	5	D
1,2-Dichloropropane	Fumigant	34541	78-87-5	0.029	MCL-US	5	D

Table 3A. Volatile organic compounds and gasoline additives, primary uses or sources, comparative thresholds, and reporting information for the USGS National Water Quality Laboratory Schedule 2020.—Continued

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property; CAS, Chemical Abstract Service; HAL, U.S. Environmental Protection Agency Lifetime Health Advisory; LRL, Laboratory reporting level; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; NL-CA, California Department of Public Health notification level; RSD5, risk-specific dose at 10^{-5} µg/L; µg/L, micrograms per liter; na, not available; D, detected; —, not detected]

Constituent (synonym or abbreviation)	Primary use or source	USGS parameter code	CAS number	LRL (µg/L)	Threshold type ¹	Threshold value (µg/L)	Detection
1,3-Dichloropropane	Fumigant	77173	142-28-9	0.06	MCL-US	5	—
2,2-Dichloropropane	Fumigant	77170	594-20-7	0.05	na	na	—
1,1-Dichloropropene	Organic synthesis	77168	563-58-6	0.026	na	na	—
<i>cis</i> -1,3-Dichloropropene	Fumigant	34704	10061-01-5	0.05	RSD5	³⁴	—
<i>trans</i> -1,3-Dichloropropene	Fumigant	34699	10061-02-6	0.09	RSD5	³⁴	—
Diethyl ether	Solvent	81576	60-29-7	0.08	na	na	—
Diisopropyl ether (DIPE)	Gasoline oxygenate	81577	108-20-3	0.10	na	na	—
Ethylbenzene	Gasoline hydrocarbon	34371	100-41-4	0.030	MCL-CA	300	D
Ethyl <i>tert</i> -butyl ether (ETBE)	Gasoline oxygenate	50004	637-92-3	0.030	na	na	—
Ethyl methacrylate	Organic synthesis	73570	97-63-2	0.18	na	na	—
1-Ethyl-2-methylbenzene <i>o</i> -Ethyl toluene)	Gasoline hydrocarbon	77220	611-14-3	0.06	na	na	D
Hexachlorobutadiene	Organic synthesis	39702	87-68-3	0.14	HAL	1	—
Hexachloroethane	Solvent	34396	67-72-1	0.14	HAL	1	—
2-Hexanone (<i>n</i> -Butyl methyl ketone)	Solvent	77103	591-78-6	0.4	na	na	—
Isopropylbenzene (Cumene)	Gasoline hydrocarbon	77223	98-82-8	0.038	NL-CA	770	D
4-Isopropyl-1-methylbenzene	Gasoline hydrocarbon	77356	99-87-6	0.08	na	na	—
Methyl acrylate	Organic synthesis	49991	96-33-3	1.0	na	na	—
Methyl acrylonitrile	Organic synthesis	81593	126-98-7	0.40	na	na	—
Methyl bromide (Bromomethane)	Fumigant	34413	74-83-9	0.26	HAL	10	—
Methyl <i>tert</i> -butyl ether (MTBE)	Gasoline oxygenate	78032	1634-04-4	0.10	MCL-CA	13	D
Methyl iodide (Iodomethane)	Organic synthesis	77424	74-88-4	0.50	na	na	—
Methyl isobutyl ketone (MIBK)	Solvent	78133	108-10-1	0.37	NL	120	—
Methyl methacrylate	Organic synthesis	81597	80-62-6	0.20	na	na	—
Methyl <i>tert</i> -pentyl ether (<i>tert</i> -Amyl methyl ether, TAME)	Gasoline oxygenate	50005	994-05-8	0.04	na	na	—
Naphthalene	Gasoline hydrocarbon	34696	91-20-3	0.52	HAL	100	—
<i>n</i> -Propylbenzene	Solvent	77224	103-65-1	0.042	NL-CA	260	—
Styrene	Gasoline hydrocarbon	77128	100-42-5	0.042	MCL-US	100	—
1,1,1,2-Tetrachloroethane	Solvent	77562	630-20-6	0.030	HAL	70	—
1,1,2,2-Tetrachloroethane	Solvent	34475	127-18-4	0.030	MCL-US	5	—
Tetrachloroethene (PCE)	Solvent	32102	56-23-5	0.06	MCL-CA	0.5	D
Tetrahydrofuran	Solvent	81607	109-99-9	1.0	na	na	D
1,2,3,4-Tetramethylbenzene	Gasoline hydrocarbon	49999	488-23-3	0.14	na	na	—
1,2,3,5-Tetramethylbenzene (Isodurene)	Gasoline hydrocarbon	50000	527-53-7	0.14	na	na	—

Table 3A. Volatile organic compounds and gasoline additives, primary uses or sources, comparative thresholds, and reporting information for the USGS National Water Quality Laboratory Schedule 2020.—Continued

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property; CAS, Chemical Abstract Service; HAL, U.S. Environmental Protection Agency Lifetime Health Advisory; LRL, Laboratory reporting level; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; NL-CA, California Department of Public Health notification level; RSD5, risk-specific dose at 10^{-5} µg/L; µg/L, micrograms per liter; na, not available; D, detected; —, not detected]

Constituent (synonym or abbreviation)	Primary use or source	USGS parameter code	CAS number	LRL (µg/L)	Threshold type ¹	Threshold value (µg/L)	Detection
Toluene	Gasoline hydrocarbon	34010	108-88-3	0.02	MCL-CA	150	D
1,2,3-Trichlorobenzene	Organic synthesis	77613	87-61-6	0.18	na	na	—
1,2,4-Trichlorobenzene	Solvent	34551	120-82-1	0.12	MCL-CA	5	—
1,1,1-Trichloroethane (TCA)	Solvent	34516	79-34-5	0.08	MCL-CA	1	—
1,1,2-Trichloroethane	Solvent	34511	79-00-5	0.04	MCL-US	5	—
Trichloroethene (TCE)	Solvent	39180	79-01-6	0.038	MCL-US	5	D
Trichlorofluoromethane (CFC-11)	Refrigerant	34488	75-69-4	0.08	MCL-CA	150	D
1,2,3-Trichloropropane (1,2,3-TCP)	Solvent/organic synthesis	77443	96-18-4	0.18	HAL	40	D
1,1,2-Trichlorotrifluoroethane (CFC-113)	Refrigerant	77652	76-13-1	0.038	MCL-US	1,200	D
1,2,3-Trimethylbenzene	Gasoline hydrocarbon	77221	526-73-8	0.06	na	na	D
1,2,4-Trimethylbenzene	Gasoline hydrocarbon	77222	95-63-6	0.056	NL-CA	330	D
1,3,5-Trimethylbenzene	Organic synthesis	77226	108-67-8	0.044	NL-CA	330	—
Vinyl bromide (Bromoethene)	Fire retardant	50002	593-60-2	0.10	na	na	—
Vinyl chloride (Chloroethene)	Organic synthesis	39175	75-01-4	0.08	MCL-CA	0.5	—
<i>m</i> - and <i>p</i> -Xylene	Gasoline hydrocarbon	85795	108-38-3/106-42-3	0.06	MCL-CA	1,750	D
<i>o</i> -Xylene	Gasoline hydrocarbon	77135	95-47-6	0.038	MCL-CA	1,750	D

¹ Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists.

² The MCL-US thresholds for trihalomethanes is the sum of chloroform, bromoform, bromodichloromethane, and dibromochloromethane.

³ The RSD5 threshold for 1,3-dichloropropene is the sum of its isomers (*cis* and *trans*).

Table 3B. Gasoline oxygenates and their degradates, primary uses or sources, comparative thresholds, and reporting information for the USGS National Water Quality Laboratory Schedule 4024.

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property; CAS, Chemical Abstract Service; LRL, Laboratory reporting level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; NL-CA, California Department of Public Health notification level; na, not available; µg/L, micrograms per liter; D, detected; —, not detected]

Constituent	Primary use or source	USGS parameter code	CAS number	LRL (µg/L)	Threshold type ¹	Threshold (µg/L)	Detection
Acetone	Degradate/solvent	81552	67-64-1	1.2	na	6000	D
<i>tert</i> -Amyl alcohol	Oxygenate	77073	75-85-4	1.0	na	na	—
<i>tert</i> -Butyl alcohol (TBA)	Degradate	77035	75-65-0	1	NL	12	—
Diisopropyl ether	Oxygenate	81577	108-20-3	0.04	na	na	—
Ethyl <i>tert</i> -butyl ether (ETBE)	Oxygenate	50004	637-92-3	0.04	na	na	—
Methyl acetate	Degradate	77032	79-20-9	0.43	na	na	—
Methyl <i>tert</i> -butyl ether (MTBE)	Oxygenate	78032	1634-04-4	0.04	MCL-CA	13	D
Methyl <i>tert</i> -pentyl ether (TAME)	Oxygenate	50005	994-05-8	0.030	na	na	—

¹Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists.

Table 3C. 1,2-Dibromo-3-chloropropane (DBCP) and 1,2-dibromoethane (EDB), primary use or source, comparative thresholds, and reporting information for the USGS National Water Quality Laboratory Schedule 1306.

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property; CAS, Chemical Abstract Service; LRL, Laboratory reporting level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; µg/L, micrograms per liter; D, detected; —, not detected]

Constituent	Primary use or source	USGS parameter code	CAS number	MRL (µg/L)	Threshold type ¹	Threshold (µg/L)	Detection
1,2-Dibromo-3-chloropropane (DBCP)	Fumigant	82625	96-12-8	0.030	MCL-US	0.2	D
1,2-Dibromoethane (EDB)	Fumigant	77651	106-93-4	0.040	MCL-US	0.05	—

¹ Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists.

Table 3D. Pesticides and pesticide degradates, primary uses or sources, comparative thresholds, and reporting information for the USGS National Water Quality Laboratory Schedule 2033.

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property; CAS, Chemical Abstract Service; HAL, U.S. Environmental Protection Agency Lifetime Health Advisory; LRL, Laboratory reporting level; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; RSD5, risk specific dose at 10^{-5} µg/L; µg/L, micrograms per liter; na, not available; D, detected; —, not detected]

Constituent	Primary use or source	USGS parameter code	CAS number	LRL (µg/L)	Threshold type ¹	Threshold (µg/L)	Detection
Acetochlor	Herbicide	49260	34256-82-1	0.006	na	na	D
Alachlor	Herbicide	46342	15972-60-8	0.005	MCL-US	2	D
Atrazine	Herbicide	39632	1912-24-9	0.007	MCL-CA	1	D
Azinphos-methyl	Insecticide	82686	86-50-0	0.05	na	na	—
Azinphos-methyl-oxon	Insecticide degradate	61635	961-22-8	0.070	na	na	—
Benfluralin	Herbicide	82673	1861-40-1	0.01	na	na	—
Carbaryl	Insecticide	82680	63-25-2	0.04	RSD5	400	—
Carbofuran	Herbicide	82674	1563-66-2	0.02	MCL-CA	18	—
2-Chloro-2,6-diethylacetanilide	Herbicide degradate	61618	6967-29-9	0.0021	na	na	—
4-Chloro-2-methylphenol	Herbicide degradate	61633	1570-64-5	0.0056	na	na	—
Chlorpyrifos	Insecticide	38933	2921-88-2	0.005	HAL	2	—
Chlorpyrifos oxon	Insecticide degradate	61636	5598-15-2	0.0562	na	na	—
Cyanazine	Herbicide	04041	21725-46-2	0.018	HAL	1	—
Cyfluthrin	Insecticide	61585	68359-37-5	0.0267	na	na	—
λ-Cyhalothrin	Insecticide	61595	91465-08-6	0.0089	na	na	—
Cypermethrin	Insecticide	61586	52315-07-8	0.0086	na	na	—
DCPA (Dacthal)	Herbicide	82682	1861-32-1	0.003	HAL	70	—
Deethyl atrazine (2-Chloro-4-isopropylamino-6-amino-s-triazine)	Herbicide degradate	04040	6190-65-4	0.006	na	na	D
Desulfinylfipronil	Insecticide degradate	62170	na	0.012	na	na	D
Desulfinylfipronil amide	Insecticide degradate	62169	na	0.029	na	na	—
Diazinon	Insecticide	39572	333-41-5	0.005	HAL	1.0	D
3,4-Dichloroaniline	Herbicide degradate	61625	95-76-1	0.0045	na	na	D
3,5-Dichloroaniline	Herbicide degradate	61627	626-43-7	0.004	na	na	D
Dichlorvos	Fumigant	38775	62-73-7	0.0118	na	na	—
Dicrotophos	Insecticide	38454	141-66-2	0.0843	na	na	—
Dieldrin	Insecticide	39381	60-57-1	0.009	RSD5	0.02	D
2,6-Diethylaniline	Herbicide degradate	82660	579-66-8	0.006	na	na	—
Dimethoate	Insecticide	82662	60-51-5	0.0061	na	na	—
Disulfoton	Insecticide	82677	298-04-4	0.021	HAL	0.7	—
Disulfoton sulfone	Insecticide degradate	61640	2497-06-5	0.0059	na	na	—
α-Endosulfan	Insecticide	34362	959-98-8	0.005	na	na	—
Endosulfan sulfate	Insecticide degradate	61590	1031-07-8	0.0138	na	na	—
EPTC (S-Ethyl dipropylthiocarbamate)	Herbicide	82668	759-94-4	0.004	na	na	D
Ethion	Insecticide	82346	563-12-2	0.004	na	na	—
Ethion monoxon	Insecticide degradate	61644	17356-42-2	0.002	na	na	—
Ethoprophos	Herbicide	82672	13194-48-4	0.005	na	na	—
2-Ethyl-6-methylaniline	Herbicide degradate	61620	24549-06-2	0.0045	na	na	—
Fenamiphos	Insecticide	61591	22224-92-6	0.029	HAL	0.7	—
Fenamiphos sulfone	Insecticide degradate	61645	31972-44-8	0.0491	na	na	—
Fenamiphos sulfoxide	Insecticide degradate	61646	31972-43-7	0.0387	na	na	—
Fipronil	Insecticide	62166	120068-37-3	0.016	na	na	—
Fipronil sulfide	Insecticide degradate	62167	120067-83-6	0.013	na	na	D
Fipronil sulfone	Insecticide degradate	62168	120068-36-2	0.024	na	na	—
Fonofos	Insecticide	04095	944-22-9	0.003	HAL	10	—
Hexazinone	Herbicide	04025	51235-04-2	0.0129	HAL	400	D
Iprodione	Fungicide	61593	36734-19-7	0.538	na	na	—
Isofenphos	Insecticide	61594	25311-71-1	0.0034	na	na	—
Malaoxon	Insecticide degradate	61652	1634-78-2	0.0298	na	na	—
Malathion	Insecticide	39532	121-75-5	0.027	HAL	100	—

Table 3D. Pesticides and pesticide degradates, primary uses or sources, comparative thresholds, and reporting information for the USGS National Water Quality Laboratory Schedule 2033.—Continued

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property; CAS, Chemical Abstract Service; HAL, U.S. Environmental Protection Agency Lifetime Health Advisory; LRL, Laboratory reporting level; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; RSD5, risk specific dose at 10^{-5} µg/L; µg/L, micrograms per liter; na, not available; D, detected; —, not detected]

Constituent	Primary use or source	USGS parameter code	CAS number	LRL (µg/L)	Threshold type ¹	Threshold (µg/L)	Detection
Metalaxyl	Fungicide	61596	57837-19-1	0.0051	na	na	—
Methodathion	Insecticide	61598	950-37-8	0.0058	na	na	—
Metolachlor	Herbicide	39415	51218-45-2	0.006	HAL	700	D
Metribuzin	Herbicide	82630	21087-64-9	0.006	HAL	70	—
Molinate	Herbicide	82671	2212-67-1	0.003	MCL-CA	20	—
Myclobutanil	Fungicide	61599	88671-89-0	0.008	na	na	D
1-Naphthol	Insecticide degradate	49295	90-15-3	0.0882	na	na	D
Oxyfluorfen	Herbicide	61600	42874-03-3	0.0073	na	na	—
Paraoxon-methyl	Insecticide	61664	950-35-6	0.0299	na	na	—
Parathion-methyl	Insecticide	82667	298-00-0	0.015	HAL	1	—
Pendimethalin	Herbicide	82683	40487-42-1	0.022	na	na	—
cis-Permethrin	Insecticide	82687	54774-45-7	0.006	na	na	—
Phorate	Insecticide	82664	298-02-2	0.011	na	na	—
Phorate oxon	Insecticide degradate	61666	2600-69-3	0.1048	na	na	—
Phosmet	Insecticide	61601	732-11-6	0.0079	na	na	—
Phosmet oxon	Insecticide degradate	61668	3735-33-9	0.0511	na	na	—
Prometon	Herbicide	04037	1610-18-0	0.01	HAL	100	D
Prometryn	Herbicide	04036	7287-19-6	0.0054	na	na	D
Pronamide	Herbicide	82676	23950-58-5	0.004	RSD5	20.000	—
Propanil	Herbicide	82679	709-98-8	0.011	na	na	—
Propargite	Insecticide	82685	2312-35-8	0.023	na	na	—
cis-Propiconazole	Fungicide	79846	60207-90-1	0.008	na	na	—
trans-Propiconazole	Fungicide	79847	60207-90-1	0.0133	na	na	—
Propyzamide (Pronamide)	Herbicide	82676	23950-58-5	0.004	na	na	—
Simazine	Herbicide	04035	122-34-9	0.005	MCL-US	4	D
Tebuconazole	Fungicide	62852	107534-96-3	0.0136	na	na	—
Tebuthiuron	Herbicide	82670	34014-18-1	0.016	HAL	500	—
Tefluthrin	Insecticide	61606	79538-32-2	0.0077	na	na	—
Terbufos	Insecticide	82675	13071-79-9	0.017	HAL	0.4	—
Terbufos oxon sulfone	Insecticide degradate	61674	56070-15-6	0.0676	na	na	—
Terbuthylazine	Herbicide	04022	5915-41-3	0.0102	na	na	—
Thiobencarb	Herbicide	82681	28249-77-6	0.010	MCL-CA	70	—
Tribufos	Herbicide	61610	78-48-8	0.0044	na	na	—
Trifluralin	Herbicide	82661	1582-09-8	0.009	HAL	10	—

¹ Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists.

Table 3E. Polar pesticides and pesticide degradates, primary uses or sources, comparative thresholds, and reporting information for the USGS National Water Quality Laboratory Schedule 2060.

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property; CAS, Chemical Abstract Service; HAL, U.S. Environmental Protection Agency Lifetime Health Advisory; LRL, Laboratory reporting level; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; RSD5, risk specific dose at 10^{-5} µg/L; µg/L, micrograms per liter; na, not available; D, detected; —, not detected]

Constituent	Primary use or source	USGS parameter code	CAS number	LRL (µg/L)	Type of comparison threshold	Threshold type ¹	Detection
Acifluorfen	Herbicide	49315	50594-66-6	0.028	na	na	—
Aldicarb ²	Insecticide	49312	116-06-3	0.04	MCL-US	3	—
Aldicarb sulfone	Insecticide/ degradate	49313	1646-88-4	0.018	MCL-US	3	—
Aldicarb sulfoxide	Degradate	49314	1646-87-3	0.022	MCL-US	4	—
Atrazine	Herbicide	39632	1912-24-9	0.008	MCL-CA	1	—
Bendiocarb	Insecticide	50299	22781-23-3	0.020	na	na	—
Benomyl	Fungicide	50300	17804-35-2	0.022	na	na	—
Bensulfuron-methyl	Herbicide	61693	83055-99-6	0.018	na	na	—
Bentazon	Herbicide	38711	25057-89-0	0.012	MCL-CA	18	D
Bromacil	Herbicide	04029	314-40-9	0.018	HAL	70	D
Bromoxynil	Herbicide	49311	1689-84-5	0.028	na	na	—
Caffeine	Wastewater indicator	50305	58-08-2	0.018	na	na	D
Carbaryl	Herbicide	49310	63-25-2	0.018	RSD5-US	400	—
Carbofuran	Herbicide	49309	1563-66-2	0.016	MCL-CA	18	—
Chloramben, methyl ester	Herbicide	61188	7286-84-2	0.024	na	na	—
Chlorimuron-ethyl	Herbicide	50306	90982-32-4	0.032	na	na	—
3-(4-Chlorophenyl)- 1-methyl urea	Degradate	61692	5352-88-5	0.036	na	na	—
Clopyralid	Herbicide	49305	1702-17-6	0.024	na	na	—
Cycloate	Herbicide	04031	1134-23-2	0.014	na	na	—
2,4-D (2,4-Dichlorophenoxyacetic acid) plus 2,4-D methyl ester (2,4-Dichlorophenoxyacetic acid methyl ester)	Herbicides	66496	94-75-7; 1928-38-7	0.038	MCL-US	70	—
2,4-DB (4-[2,4-Dichlorophenoxy] butyric acid)	Herbicide	38746	94-82-6	0.020	na	na	—
DCPA (Dacthal) monoacid	Degradate	49304	887-54-7	0.028	na	na	—
Deethylatrazine (2-Chloro-4- isopropylamino-6-amino- <i>s</i> - triazine)	Degradate	04040	6190-65-4	0.028	na	na	—
Deethyldeisopropyl atrazine (2-Chlor-4,6-diamino- <i>s</i> - triazine)	Degradate	04039	3397-62-4	0.04	na	na	D
Deisopropyl atrazine (2-chloro-6-ethylamino-4- amino- <i>s</i> -triazine)	Degradate	04038	1007-28-9	0.08	na	na	D
Dicamba	Herbicide	38442	1918-00-9	0.036	HAL	4000	—
Dichlorprop	Herbicide	49302	120-36-5	0.028	na	na	—
Dinoseb	Herbicide	49301	88-85-7	0.038	MCL-CA	7	D
Diphenamid	Herbicide	04033	957-51-7	0.010	HAL	200	—
Diuron	Herbicide	49300	330-54-1	0.015	RSD5	20	D
Fenuron	Herbicide	49297	101-42-8	0.019	na	na	D
Flumetsulam	Herbicide	61694	98967-40-9	0.040	na	na	—
Fluometuron	Herbicide	38811	2164-17-2	0.016	HAL	90	—

Table 3E. Polar pesticides and pesticide degradates, primary uses or sources, comparative thresholds, and reporting information for the USGS National Water Quality Laboratory Schedule 2060.—Continued

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property; CAS, Chemical Abstract Service; HAL, U.S. Environmental Protection Agency Lifetime Health Advisory; LRL, Laboratory reporting level; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; RSD5, risk specific dose at 10^{-5} µg/L; µg/L, micrograms per liter; na, not available; D, detected; —, not detected]

Constituent	Primary use or source	USGS parameter code	CAS number	LRL (µg/L)	Type of comparison threshold	Threshold type ¹	Detection
Hydroxyatrazine (2-Hydroxy-4-isopropylamino-6-ethylamino-s-triazine)	Degradate	50355	2163-68-0	0.032	na	na	—
3-Hydroxycarbofuran	Degradate	49308	16655-82-6	0.008	na	na	—
Imazaquin	Herbicide	50356	81335-37-7	0.036	na	na	—
Imazethapyr	Herbicide	50407	81335-77-5	0.038	na	na	D
Imidacloprid	Insecticide	61695	138261-41-3	0.020	na	na	—
Linuron	Herbicide	38478	330-55-2	0.014	na	na	—
MCPA (2-Methyl-4-chlorophenoxyacetic acid)	Herbicide	38482	94-74-6	0.030	HAL	30	—
MCPB (4-[2-Methyl-4-chlorophenoxy]butyric acid)	Herbicide	38487	94-81-5	0.010	na	na	—
Metalaxyl	Fungicide	50359	57837-19-1	0.012	na	na	—
Methiocarb	Insecticide	38501	2032-65-7	0.010	na	na	—
Methomyl	Insecticide	49296	16752-77-5	0.020	HAL	200	—
Metsulfuron methyl ²	Herbicide	61697	74223-64-6	0.025	na	na	D
Neburon	Herbicide	49294	555-37-3	0.012	na	na	—
Nicosulfuron	Herbicide	50364	111991-09-4	0.04	na	na	—
Norflurazon	Herbicide	49293	27314-13-2	0.020	na	na	—
Oryzalin	Herbicide	49292	19044-88-3	0.012	na	na	—
Oxamyl	Insecticide	38866	23135-22-0	0.030	MCL-CA	50	D
Picloram	Herbicide	49291	1918-02-01	0.032	MCL-US	500	—
Propham	Herbicide	49236	122-42-9	0.030	HAL	100	—
Propiconazole	Fungicide	50471	60207-90-1	0.010	na	na	—
Propoxur	Insecticide	38538	114-26-1	0.008	na	na	—
Siduron	Herbicide	38548	1982-49-6	0.020	na	na	—
Sulfometuron-methyl	Herbicide	50337	74222-97-2	0.038	na	na	—
Tebuthiuron	Herbicide	82670	34014-18-1	0.026	HAL	500	—
Terbacil	Herbicide	04032	5902-51-2	0.016	HAL	90	—
Triclopyr	Herbicide	49235	55335-06-3	0.026	na	na	—

¹Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists.

²Although listed as an LRLs, these constituents were reported using method reporting levels (MRLs) during this study.

Table 3F. Constituents of special interest, primary use or source, comparative thresholds, and reporting information for the Montgomery Watson Harza Laboratory.

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property; CAS, Chemical Abstract Service; MRL, minimum reporting level; NL-CA, California Department of Public Health notification level; µg/L, micrograms per liter; D, detected]

Constituent	Primary use or source	CAS number	MRL (µg/L)	Threshold type	Threshold (µg/L)	Detection
Perchlorate	Rocket fuel, fireworks, flares	14797-73-0	0.5	MCL-CA	6	D
1,2,3-Trichloropropane (1,2,3-TCP)	Industrial solvent, organic synthesis	96-18-4	0.005	HAL	40	D
<i>N</i> -Nitrosodimethylamine (NDMA)	Rocket fuel, plasticizer, disinfection-by-product	62-75-9	0.002	NL-CA	0.010	D

Table 3G. Nutrients and dissolved organic carbon, comparative thresholds, and reporting information for the USGS National Water Quality Laboratory Schedule 2755 and Lab Code 2612.

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property; CAS, Chemical Abstract Service; HAL, U.S. Environmental Protection Agency Lifetime health advisory level; LRL, Laboratory reporting level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; na, not available; mg/L, milligrams per liter; D, detected]

Constituent	USGS parameter code	CAS number	LRL (mg/L)	Threshold type ¹	Threshold (mg/L)	Detection
Ammonia (as nitrogen)	00608	7664-41-7	0.04	HAL	² 24.7	D
Nitrite (as nitrogen)	00613	14797-65-0	0.002	MCL-US	1	D
Nitrate plus nitrite (as nitrogen)	00631	na	0.060	MCL-US	10	D
Total nitrogen (ammonia, nitrite, nitrate, organic nitrogen)	62854	17778-88-0	0.06	na	na	D
Phosphorus, orthophosphate (as phosphorus)	00671	14265-44-2	0.006	na	na	D
Dissolved organic carbon (DOC)	00681	na	0.33	na	na	D

¹ Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists.

² The published HAL for ammonia is 30 mg/L as NH₃; using molar mass ratios, the HAL can be converted for ammonia as nitrogen. This value is 24.7 mg/L.

Table 3H. Major and minor ions and trace elements, comparative thresholds, and reporting information for the USGS National Water Quality Laboratory Schedule 1948.

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property; CAS, Chemical Abstract Service; HAL, U.S. Environmental Protection Agency Lifetime Health Advisory; LRL, Laboratory reporting level; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; SMCL-CA, California Department of Public Health secondary maximum contaminant level; SMCL-US, U.S. Environmental Protection Agency secondary maximum contaminant level; NL-CA, California Department of Public Health notification level; na, not available; mg/L, milligrams per liter; µg/L, micrograms per liter; D, detected; —, not detected]

Constituent	USGS parameter code	CAS number	LRL	Threshold type ¹	Threshold	Detection
Major and minor ions (mg/L)						
Bromide	71870	24959-67-9	0.02	na	na	D
Calcium	00915	7440-70-2	0.02	na	na	D
Chloride	00940	16887-00-6	0.20	SMCL-CA	250 (500) ²	D
Fluoride	00950	16984-48-8	0.10	MCL-CA	2	D
Iodide	78165	7553-56-2	0.002	na	na	D
Magnesium	00925	7439-95-4	0.008	na	na	D
Potassium	00935	7440-09-7	0.16	na	na	D
Silica	00955	7631-86-9	0.04	na	na	D
Sodium	00930	7440-23-5	0.20	na	na	D
Sulfate	00945	14808-79-8	0.18	SMCL-CA	250 (500) ²	D
Residue on evaporation (total dissolved solids, TDS)	70300	na	10	SMCL-US	500 (1,000) ²	D
Trace elements (µg/L)						
Aluminum	01106	7429-90-5	1.6	MCL-CA	1,000	D
Antimony	01095	7440-36-0	0.2	MCL-US	6	D
Arsenic	01000	7440-38-2	0.12	MCL-US	10	D
Barium	01005	7440-39-3	0.2	MCL-CA	1,000	D
Beryllium	01010	7440-41-7	0.06	MCL-US	4	D
Boron	01020	7440-42-8	8	HAL	1,000	D
Cadmium	01025	7440-43-9	0.04	MCL-US	5	D
Chromium	01030	7440-47-3	0.04	MCL-CA	50	D
Cobalt	01035	7440-48-4	0.040	na	na	D
Copper	01040	7440-50-8	0.4	HAL	1,300	D
Iron	01046	7439-89-6	6	SMCL-CA	300	D
Lead	01049	7439-92-1	0.08	HAL	15	D
Lithium	01130	7439-93-2	0.6	na	na	D
Manganese	01056	7439-96-5	0.2	SMCL-CA	50	D
Mercury	71890	7439-97-6	0.010	MCL-US	2	—
Molybdenum	01060	7439-98-7	0.4	HAL	40	D
Nickel	01065	7440-02-0	0.06	MCL-CA	100	D
Selenium	01145	7782-49-2	0.08	MCL-US	50	D
Silver	01075	7440-22-4	0.20	HAL	100	—
Strontium	01080	7440-24-6	0.4	HAL	4,000	D
Thallium	01057	7440-28-0	0.04	MCL-US	2	D
Tungsten	01155	7440-33-7	0.06	na	na	D
Uranium	22703	7440-61-1	0.04	MCL-US	30	D
Vanadium	01085	7440-62-2	0.10	NL-CA	50	D
Zinc	01090	7440-66-6	0.6	HAL	2,000	D

¹ Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists.

² The recommended SMCL-CA and SMCL-US thresholds for chloride, sulfate, and TDS are listed with the upper thresholds in parentheses.

Table 3I. Arsenic, chromium, and iron species, comparative thresholds, and reporting information for the USGS Trace Metal Laboratory, Boulder, Colorado.

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property; CAS, Chemical Abstract Service; MDL, method detection limit; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; SMCL-CA, California Department of Public Health secondary maximum contaminant level; µg/L, micrograms per liter; na, not available]

Constituent (valence state)	USGS parameter code	CAS number	MDL (µg/L)	Threshold type ¹	Threshold (µg/L)	Detection
Arsenic (total)	01000	7440-38-2	0.5	MCL-US	10	D
Arsenic(III)	99034	22569-72-8	1	na	na	D
Chromium (total)	01030	7440-47-3	1	MCL-CA	50	D ²
Chromium(VI)	01032	18540-29-9	1	na	na	D ²
Iron (total)	01046	7439-89-6	2	SMCL-CA	300	D
Iron(II)	01047	7439-89-6	2	na	na	D

Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists.

² Data are not reported because of suspected contamination of samples during the preservation process.

Table 3J. Isotopic and radioactive constituents, comparative thresholds, and reporting information for laboratories.

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property; CAS, Chemical Abstract Service; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; δ , notation, in per mil, of the differences in oxygen-18/oxygen-16 and hydrogen-2/hydrogen-1 ratios relative to Standard Mean Ocean Water (SMOW), and the difference in the carbon-13/carbon-12 ratio relative to University of Chicago Pee Dee Formation Standard; MU, method uncertainty; MRL, minimum reporting level; SSMD, sample-specific minimum detectable concentration; na, not available; pCi/L, picocuries per liter; D, detected]

Constituent	USGS parameter code	CAS number	Reporting level type	Reporting level or uncertainty	Threshold type ¹	Threshold	Detection
Stable isotope ratios (per mil)							
$\delta^2\text{H}$ of water ²	82082	na	MU	2	na	na	D
$\delta^{18}\text{O}$ of water ²	82085	na	MU	0.20	na	na	D
$\delta^{15}\text{N}$ of nitrate ²	82690	na	MU	na	na	na	D
$\delta^{18}\text{O}$ of nitrate ²	63041	na	MU	na	na	na	D
$\delta^{13}\text{C}$ of dissolved carbonates ³	82081	na	1 sigma	0.05	na	na	D
Radioactive constituents (percent modern)							
Carbon-14 ⁴	49933	14762-75-5	1 sigma	0.0015	na	na	D
Radioactive constituents (pCi/L)							
Tritium ^{5,6}	07000	10028-17-8	MRL	1	MCL-CA	20,000	D
Radon-222 ⁷	82303	14859-67-7	SSMD	19–44	Proposed	300 (4,000) ⁸	D
MCL-US							
Gross-alpha radioactivity, 72-hour count ⁹	62636	12587-46-1	SSMD	0.42–6.4	MCL-US	15	D
Gross-alpha radioactivity, 30-day count ⁹	62639	12587-46-1	SSMD	0.24–5.0	MCL-US	15	D
Gross-beta radioactivity, 72-hour count ⁹	62642	12587-47-2	SSMD	0.52–1.8	MCL-CA	50	D
Gross-beta radioactivity, 30-day count ⁹	62645	12587-47-2	SSMD	0.38–4.4	MCL-CA	50	D
Radium-226 ⁹	09511	13982-63-3	SSMD	0.008–0.018	MCL-US ¹⁰	5	D
Radium-228 ⁹	81366	15262-20-1	SSMD	0.085–0.23	MCL-US ¹⁰	5	D
Uranium-234 ⁹	22610	13966-29-1	SSMD	0.1	MCL-CA ¹¹	20	D
Uranium-235 ⁹	22620	15117-96-1	SSMD	0.1	MCL-CA ¹¹	20	D
Uranium-238 ⁹	22603	7440-61-1	SSMD	0.1	MCL-CA ¹¹	20	D

¹ Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists.

² U.S. Geological Survey Stable Isotope Laboratory, Reston, Virginia.

³ University of Waterloo, Environmental Isotope Laboratory.

⁴ University of Arizona, Accelerator Mass Spectrometry Laboratory (contract laboratory).

⁵ U.S. Geological Survey Stable Isotope and Tritium Laboratory, Menlo Park, California.

⁶ Lawrence Livermore National Laboratory.

⁷ U.S. Geological Survey National Water Quality Laboratory.

⁸ Two MCLs have been proposed for Radon-222. The proposed alternative MCL is in parentheses.

⁹ Eberline Analytical Services.

¹⁰ Combined radium-226 plus radium-228.

¹¹ Combined Uranium-234 plus uranium-235 plus uranium-238.

Table 3K. Noble gases, comparison thresholds, and reporting information for the Lawrence Livermore National Laboratory.

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property; CAS, Chemical Abstract Service; MCL-CA, California Department of Public Health maximum contaminant level; MU, method uncertainty; na, not available; cm³STP/g, cubic centimeter of gas at standard temperature and pressure per gram of water; pCi/L, picocuries per liter; D, detected]

Constituent	USGS parameter code	CAS number	MU (percent)	Reporting units	Threshold type	Threshold (pCi/L)	Detection
Argon	85563	7440-37-1	2	cm ³ STP/g	na	na	D
Helium-3/helium-4 ratio	61040	na/7440-59-7	0.75	na	na	na	D
Helium-4	85561	7440-59-7	2	cm ³ STP/g	na	na	D
Krypton	85565	7439-90-9	3	cm ³ STP/g	na	na	D
Neon	61046	7440-01-09	2	cm ³ STP/g	na	na	D
Xenon	85567	7440-63-3	3	cm ³ STP/g	na	na	D

Table 3L. Microbial constituents, comparison thresholds, and reporting information for the USGS Ohio Microbiology Laboratory parameter codes 90901, 90900, 99335 and 99332.

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; TT, treatment technique - a required process intended to reduce the level of a contaminant in drinking water; mL, milliliters; D, detected; na, not available; —, not detected]

Constituent	USGS parameter code	Primary use/source	MDL	Threshold type ¹	Threshold	Detection
<i>Escherichia coli</i> ²	90901	Sewage and animal waste indicator/ Intestinal tracts of humans and animals	1 colony/100 mL	TT	No fecal coliforms are allowed.	—
Total coliform ² (including fecal coliform and <i>E. coli</i>)	90900	Water-quality indicator/Soil, water, and intestinal tracts of animals	1 colony/100 mL	MCL-US	No more than 5 percent of samples coliform-positives in one month. Every sample that has total coliforms must be analyzed for fecal coliforms; no fecal coliforms are allowed.	D
F-specific coliphage ³	99335	Viral indicator/Intestinal tracts of warm-blooded animals	na	TT	99.99 percent killed/inactivated	—
Somatic coliphage ³	99332	Viral indicator/Fecal contaminated waters	na	TT	99.99 percent killed/inactivated	D

¹ Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists.

² Analyzed in the field.

³ Analyzed by the U.S. Geological Survey Ohio Microbiology Laboratory.

Table 4. Water-quality indicators in samples collected for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.

[The five-digit parameter code below the constituent name is used by the U.S. Geological Survey to uniquely identify a specific constituent or property. KING, Kings study area; KWH, Kaweah study area; TULE, Tule study area; TLR, Tulare Lake study area; KINGFP, Kings study area flow-path well; HWY99T, Highway 99 transect well; C, celsius; E, estimated value; mg/L, milligrams per liter; mm, millimeter; $\mu\text{S}/\text{cm}$, microsiemens per centimeter; na, not available; nc, sample not collected; NTU, nephelometric turbidity unit; RL, reporting level; TT, treatment technique - a required process intended to reduce the level of a contaminant in drinking water; SMCL-US, U.S. Environmental Protection Agency secondary maximum contaminant level; SMCL-CA, California Department of Public Health secondary maximum contaminant level; <, less than; *, value is above threshold]

GAMA identification no.	Turbidity (NTU) (63676)	Dissolved oxygen (mg/L) (00300)	Water temperature ($^{\circ}\text{C}$) (00010)	pH, field (standard units) (00400)	pH, laboratory (standard units) (00403)	Specific conductance, field ($\mu\text{S}/\text{cm}$ at 25°C) (00095)	Alkalinity, field (mg/L as CaCO_3) (29802)	Alkalinity, laboratory, fixed endpoint (pH 4.5) (mg/L as CaCO_3) (29801)
RL	0.1	0.2	0.0–38.5	0–14	0–14	5	1	1
Threshold type	TT	na	na	SMCL-US	SMCL-US	SMCL-CA ¹	na	na
Threshold	1	na	na	6.5–8.5	6.5–8.5	900 (1,600)	na	na
Grid wells								
KING-01	nc	<0.2	21.5	nc	nc	*939	nc	nc
KING-02	nc	0.2	20.5	nc	nc	778	nc	nc
KING-03	nc	<0.2	21.0	nc	nc	454	nc	nc
KING-04	0.2	2.0	23.0	8.2	8.3	534	142	147
KING-05	nc	<0.2	22.5	nc	nc	770	nc	nc
KING-06	nc	<0.2	24.5	nc	nc	170	nc	nc
KING-07	nc	1.1	19.0	nc	nc	218	nc	nc
KING-08	nc	4.4	20.5	nc	nc	147	nc	nc
KING-09	nc	4.1	21.0	nc	8.3	171	nc	51
KING-10	nc	5.3	20.0	nc	7.8	259	nc	110
KING-11	nc	5.7	22.5	nc	8.0	409	nc	149
KING-12	nc	7.9	21.0	nc	7.4	522	nc	202
KING-13	nc	6.9	23.0	nc	7.7	318	nc	132
KING-14	nc	3.2	24.5	nc	nc	220	nc	nc
KING-15	nc	6.5	22.5	nc	7.6	372	nc	136
KING-16	nc	8.7	21.5	nc	7.7	206	nc	89
KING-17	0.1	4.7	23.5	7.9	7.8	322	131	128
KING-18	nc	6.6	18.0	nc	nc	123	nc	nc
KING-19	nc	4.3	21.5	nc	nc	367	nc	nc
KING-20	0.1	4.5	15.5	7.4	8.2	133	54	57
KING-21	nc	0.3	19.5	nc	nc	415	nc	nc
KING-22	nc	6.6	21.5	nc	nc	145	nc	nc
KING-23	nc	9.8	20.5	nc	nc	350	nc	nc
KING-24	nc	5.9	21.0	nc	nc	480	nc	nc
KING-25	nc	3.1	22.0	nc	6.8	522	nc	134
KING-26	nc	0.3	21.0	nc	nc	*1510	nc	nc
KING-27	nc	6.1	30.0	nc	nc	254	nc	nc
KING-28	nc	2.2	20.0	nc	nc	153	nc	nc
KING-29	nc	3.1	21.5	nc	nc	332	nc	nc
KING-30	nc	5.1	22.0	nc	7.1	262	nc	102
KING-31	nc	1.3	19.0	nc	nc	690	nc	nc
KING-32	nc	1.0	23.5	nc	nc	744	nc	nc
KING-33	nc	1.9	24.0	nc	nc	427	nc	nc
KING-34	nc	4.6	21.5	nc	nc	503	nc	nc
KING-35	nc	6.7	21.0	nc	nc	366	nc	nc

Table 4. Water-quality indicators in samples collected for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.—Continued

[The five-digit parameter code below the constituent name is used by the U.S. Geological Survey to uniquely identify a specific constituent or property. KING, Kings study area; KWH, Kaweah study area; TULE, Tule study area; TLR, Tulare Lake study area; KINGFP, Kings study area flow-path well; HWY99T, Highway 99 transect well; C, celsius; E, estimated value; mg/L, milligrams per liter; mm, millimeter; $\mu\text{S}/\text{cm}$, microsiemens per centimeter; na, not available; nc, sample not collected; NTU, nephelometric turbidity unit; RL, reporting level; TT, treatment technique - a required process intended to reduce the level of a contaminant in drinking water; SMCL-US, U.S. Environmental Protection Agency secondary maximum contaminant level; SMCL-CA, California Department of Public Health secondary maximum contaminant level; <, less than; *, value is above threshold]

GAMA identification no.	Turbidity (NTU) (63676)	Dissolved oxygen (mg/L) (00300)	Water temperature ($^{\circ}\text{C}$) (00010)	pH, field (standard units) (00400)	pH, laboratory (standard units) (00403)	Specific conductance, field ($\mu\text{S}/\text{cm}$ at 25 $^{\circ}\text{C}$) (00095)	Alkalinity, field (mg/L as CaCO_3) (29802)	Alkalinity, laboratory, fixed endpoint (pH 4.5) (mg/L as CaCO_3) (29801)
RL	0.1	0.2	0.0–38.5	0–14	0–14	5	1	1
Threshold type	TT	na	na	SMCL-US	SMCL-US	SMCL-CA ¹	na	na
Threshold	1	na	na	6.5–8.5	6.5–8.5	900 (1,600)	na	na
KING-36	nc	4.2	23.5	8.1	nc	222	nc	nc
KING-37	nc	7.0	20.0	nc	nc	385	nc	nc
KING-38	nc	3.2	24.5	nc	7.9	298	nc	129
KING-39	nc	<0.2	20.5	nc	nc	*1680	nc	nc
KWH-01	nc	3.1	19.0	nc	nc	309	nc	nc
KWH-02	nc	6.3	18.0	nc	nc	175	nc	nc
KWH-03	nc	6.7	18.5	nc	8.1	230	nc	78
KWH-04	nc	3.7	19.0	nc	nc	418	nc	nc
KWH-05	nc	7.0	21.5	nc	nc	*1050	nc	nc
KWH-06	nc	8.8	23.0	nc	7.0	*1000	nc	122
KWH-07	nc	2.1	21.0	nc	nc	*1050	nc	nc
KWH-08	nc	7.9	21.0	nc	nc	738	nc	nc
KWH-09	nc	8.3	18.5	nc	nc	478	nc	nc
KWH-10	nc	11	21.0	nc	nc	650	nc	nc
KWH-11	nc	0.4	22.0	nc	*9.1	366	nc	130
KWH-12	0.6	5.8	19.5	8.5	8.0	218	65.3	66
KWH-13	nc	3.9	20.0	nc	nc	327	nc	nc
KWH-14	0.1	7.9	18.5	7.9	7.2	317	106	102
KWH-15	nc	4.1	21.5	nc	nc	*1060	nc	nc
KWH-16	nc	9.5	19.5	nc	nc	493	nc	nc
KWH-17	nc	5.2	20.0	nc	nc	519	nc	nc
KWH-18	nc	7.8	19.5	nc	nc	680	nc	nc
TULE-01	0.1	4.0	23.5	*8.8	8.5	264	57.2	60
TULE-02	nc	7.3	19.5	nc	nc	430	nc	nc
TULE-03	nc	1.5	19.0	nc	*8.6	293	nc	107
TULE-04	nc	0.6	25.5	nc	nc	523	nc	nc
TULE-05	nc	0.4	27.5	nc	nc	*1120	nc	nc
TULE-06	nc	nc	33.5	nc	nc	535	nc	nc
TULE-07	nc	5.5	21.5	nc	*9.1	450	nc	98
TULE-08	1.9	1.1	25.0	*9.8	*9.7	203	74	77
TULE-09	nc	1.0	19.5	nc	nc	354	nc	nc
TULE-10	nc	7.5	21.0	nc	nc	580	nc	nc
TULE-11	nc	0.3	22.0	nc	nc	331	nc	nc
TULE-12	nc	<0.2	29.5	nc	nc	231	nc	nc
TULE-13	nc	2.2	19.5	nc	nc	409	nc	nc
TULE-14	nc	8.6	22.0	nc	nc	417	nc	nc
TULE-15	nc	0.4	26.0	nc	nc	479	nc	nc

Table 4. Water-quality indicators in samples collected for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.—Continued

[The five-digit parameter code below the constituent name is used by the U.S. Geological Survey to uniquely identify a specific constituent or property. KING, Kings study area; KWH, Kaweah study area; TULE, Tule study area; TLR, Tulare Lake study area; KINGFP, Kings study area flow-path well; HWY99T, Highway 99 transect well; C, celsius; E, estimated value; mg/L, milligrams per liter; mm, millimeter; $\mu\text{S}/\text{cm}$, microsiemens per centimeter; na, not available; nc, sample not collected; NTU, nephelometric turbidity unit; RL, reporting level; TT, treatment technique - a required process intended to reduce the level of a contaminant in drinking water; SMCL-US, U.S. Environmental Protection Agency secondary maximum contaminant level; SMCL-CA, California Department of Public Health secondary maximum contaminant level; <, less than; *, value is above threshold]

GAMA identification no.	Turbidity (NTU) (63676)	Dissolved oxygen (mg/L) (00300)	Water temperature ($^{\circ}\text{C}$) (00010)	pH, field (standard units) (00400)	pH, laboratory (standard units) (00403)	Specific conductance, field ($\mu\text{S}/\text{cm}$ at 25 $^{\circ}\text{C}$) (00095)	Alkalinity, field (mg/L as CaCO_3) (29802)	Alkalinity, laboratory, fixed endpoint (pH 4.5) (mg/L as CaCO_3) (29801)
RL	0.1	0.2	0.0–38.5	0–14	0–14	5	1	1
Threshold type	TT	na	na	SMCL-US	SMCL-US	SMCL-CA ¹	na	na
Threshold	1	na	na	6.5–8.5	6.5–8.5	900 (1,600)	na	na
TULE-16	nc	6.9	20.5	nc	nc	617	nc	nc
TULE-17	nc	6.8	20.5	nc	8.1	287	nc	85
TLR-01	nc	10.9	19.5	nc	nc	359	nc	nc
TLR-02	nc	1.0	23.5	nc	*9.1	402	nc	182
TLR-03	nc	<0.2	24.0	nc	nc	425	nc	nc
TLR-04	0.5	<0.2	25.0	8.8	8.0	791	133	137
TLR-05	0.8	0.2	21.5	*9.4	*9.2	408	146	149
TLR-06	nc	0.9	21.5	nc	8.2	*1,320	nc	243
TLR-07	nc	0.2	27.0	nc	nc	*1,110	nc	nc
TLR-08	nc	1.8	21.5	nc	*8.6	353	nc	146
TLR-09	nc	<0.2	15.5	nc	nc	*1,440	nc	nc
Understanding wells								
KINGFP-01	0.1	6.2	22.5	7.4	7.4	853	247	286
KINGFP-02	0.1	3.5	24.0	8.0	7.7	321	131	139
KINGFP-03	0.1	3.5	24.0	8.1	8.0	292	115	121
KINGFP-04	0.1	6.5	21.5	7.5	7.5	515	193	206
KINGFP-05	0.3	4.5	23.5	7.1	7.5	792	309	322
KINGFP-06	0.3	5.7	22.5	7.7	7.8	370	174	161
KINGFP-07	2.3	6.1	24.0	6.6	6.9	*1,020	305	284
KINGFP-08	2.8	8.3	21.0	7.2	7.5	796	269	249
KINGFP-09	1.5	9.1	21.5	7.4	7.5	356	150	148
KINGFP-10	0.8	5.3	21.5	7.6	7.4	343	166	142
KINGFP-11	2.3	6.4	22.5	7.5	6.5	*1,210	451	435
KINGFP-12	0.4	6.1	22.5	7.2	6.8	*2,020	465	405
KINGFP-13	0.7	4.9	23.0	7.5	7.2	866	245	220
KINGFP-14	0.4	<0.2	17.5	7.3	7.4	836	265	263
KINGFP-15	0.9	<0.2	21.0	7.3	7.6	786	249	245
HWY99T-01	nc	6.8	21.5	nc	7.8	315	nc	146

¹ The SMCL-CA for specific conductance has recommended and upper threshold values. The upper value is shown in parentheses.

Table 5. Volatile organic compounds (VOCs), gasoline oxygenates and their degradates detected in samples collected for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.

[The five-digit parameter code below the constituent name is used by the U.S. Geological Survey to uniquely identify a specific constituent or property. Samples from all 99 wells were analyzed but only samples with detections are listed. Analytes are listed in order of decreasing detection frequency in the 83 grid wells. KING, Kings study area; KWH, Kaweah study area; TULE, Tule study area; TLR, Tulare Lake study area; KINGFP, Kings study area flow-path well; µg/L, microgram per liter; LRL, laboratory reporting level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; MCL-CA, California Department of Public Health maximum contaminant level; NL-CA, California Department of Public Health notification level; HAL, U.S. Environmental Protection Agency Lifetime health advisory; na, not available; E, estimated value; V, analyte detected in sample and an associated blank thus data are not included in ground-water quality assessment; —, not detected; *, value is above threshold; percentage values are detection frequencies]

GAMA identification no.	Chloroform (trichloro- methane) (µg/L) (32106)	1,2-Dibromo- 3-chloro- propane (DBCP) (µg/L) (82625)	Tetrachloro- ethene (PCE) (µg/L) (34475)	<i>m</i> -Xylene plus <i>p</i> -xylene (µg/L) (85795)	Carbon disulfide (µg/L) (77041)	Bromo- dichloro- methane (µg/L) (32101)	Bromoform (tribromo- methane) (µg/L) (32104)	1,2-Dichloro- propane (µg/L) (34541)
LRL	0.020	0.030	0.06	0.06	0.04	0.028	0.10	0.03
Threshold type ¹	MCL-US	MCL-US	MCL-CA	MCL-CA	NL-CA	MCL-US	MCL-US	MCL-US
Threshold (µg/L)	² 80	0.2	0.5	1,750	160	² 80	² 80	5
Grid wells								
KING-07	—	—	—	—	—	—	—	—
KING-08	—	E0.02	—	—	—	—	—	—
KING-09	—	E0.02	—	—	—	—	—	—
KING-10	—	—	E0.04	E0.04	—	—	—	—
KING-11	—	E0.05	—	E0.04	—	—	—	—
KING-12	—	—	—	E0.04	—	—	—	—
KING-13	E0.04	*0.37	E0.02	—	—	—	—	—
KING-15	—	—	E0.02	—	—	—	—	—
KING-18	E0.07	E0.02	—	—	—	—	—	—
KING-19	—	E0.02	—	—	—	—	—	E0.08
KING-23	E0.04	0.1	E0.04	—	—	—	—	—
KING-24	E0.07	*0.35	—	—	0.10	—	—	—
KING-26	—	—	—	—	E0.02	—	—	—
KING-29	—	—	—	—	—	—	—	—
KING-34	—	0.17	—	—	—	—	—	0.25
KING-35	E0.02	—	—	—	—	—	—	—
KING-37	—	E0.04	—	E0.02	—	—	—	—
KING-39	—	—	—	—	E0.05	—	—	—
KWH-02	E0.06	—	—	—	—	—	—	—
KWH-03	—	—	—	—	—	—	0.13	—
KWH-05	0.18	—	—	—	—	E0.05	—	—
KWH-06	0.18	E0.05	—	—	—	—	—	—
KWH-07	—	—	0.45	—	—	—	—	—
KWH-08	E0.08	—	—	—	—	0.13	2.14	—
KWH-09	E0.08	—	—	—	—	—	—	—
KWH-10	1.35	—	—	—	—	E0.04	—	—
KWH-12	E0.04	—	0.24	—	—	—	—	—
KWH-13	E0.02	—	—	—	—	—	—	—

Table 5. Volatile organic compounds (VOCs), gasoline oxygenates and their degradates detected in samples collected for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.—Continued

[The five-digit parameter code below the constituent name is used by the U.S. Geological Survey to uniquely identify a specific constituent or property. Samples from all 99 wells were analyzed but only samples with detections are listed. Analytes are listed in order of decreasing detection frequency in the 83 grid wells. KING, Kings study area; KWH, Kaweah study area; TULE, Tule study area; TLR, Tulare Lake study area; KINGFP, Kings study area flow-path well; µg/L, microgram per liter; LRL, laboratory reporting level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; MCL-CA, California Department of Public Health maximum contaminant level; NL-CA, California Department of Public Health notification level; HAL, U.S. Environmental Protection Agency Lifetime health advisory; na, not available; E, estimated value; V, analyte detected in sample and an associated blank thus data are not included in ground-water quality assessment; —, not detected; *, value is above threshold; percentage values are detection frequencies]

GAMA identification no.	Chloroform (trichloro- methane) (µg/L) (32106)	1,2-Dibromo- 3-chloro- propane (DBCP) (µg/L) (82625)	Tetrachloro- ethene (PCE) (µg/L) (34475)	<i>m</i> -Xylene plus <i>p</i> -xylene (µg/L) (85795)	Carbon disulfide (µg/L) (77041)	Bromo- dichloro- methane (µg/L) (32101)	Bromoform (tribromo- methane) (µg/L) (32104)	1,2-Dichloro- propane (µg/L) (34541)
LRL	0.020	0.030	0.06	0.06	0.04	0.028	0.10	0.03
Threshold type ¹	MCL-US	MCL-US	MCL-CA	MCL-CA	NL-CA	MCL-US	MCL-US	MCL-US
Threshold (µg/L)	² 80	0.2	0.5	1,750	160	² 80	² 80	5
KWH-14	E0.07	—	E0.04	—	—	—	—	—
KWH-15	E0.04	—	—	—	—	E0.03	—	—
KWH-16	E0.02	—	0.11	—	—	—	—	E0.08
KWH-17	0.42	—	—	E0.04	—	0.39	0.15	—
KWH-18	0.30	—	0.17	E0.01	—	—	—	—
TULE-01	E0.01	—	—	—	—	—	—	—
TULE-02	—	—	E0.02	—	—	—	—	E0.06
TULE-04	—	E0.05	—	—	—	—	—	—
TULE-05	1.83	—	—	E0.12	E0.05	2.16	3.08	—
TULE-06	—	—	—	—	E0.05	—	—	—
TULE-09	—	—	0.22	—	—	—	—	—
TULE-10	0.31	0.18	—	—	—	E0.05	—	—
TULE-11	—	—	—	—	0.17	—	—	—
TULE-12	—	—	—	—	E0.05	—	—	—
TULE-14	—	0.10	—	E0.02	—	—	—	—
TULE-16	—	*0.22	—	E0.01	—	—	—	—
TLR-01	E0.04	—	—	—	—	—	—	—
TLR-04	—	—	—	—	E0.04	—	—	—
TLR-06	0.14	—	—	—	—	—	—	—
TLR-07	—	—	—	E0.12	—	—	—	—
TLR-08	—	—	—	—	—	—	—	—
Number of detections	23	15	11	10	8	7	4	4
Detection frequency (percent)	28	18	13	12	9.6	8.4	4.8	4.8

Table 5. Volatile organic compounds (VOCs), gasoline oxygenates and their degradates detected in samples collected for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.—Continued

[The five-digit parameter code below the constituent name is used by the U.S. Geological Survey to uniquely identify a specific constituent or property. Samples from all 99 wells were analyzed but only samples with detections are listed. Analytes are listed in order of decreasing detection frequency in the 83 grid wells. KING, Kings study area; KWH, Kaweah study area; TULE, Tule study area; TLR, Tulare Lake study area; KINGFP, Kings study area flow-path well; µg/L, microgram per liter; LRL, laboratory reporting level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; MCL-CA, California Department of Public Health maximum contaminant level; NL-CA, California Department of Public Health notification level; HAL, U.S. Environmental Protection Agency Lifetime health advisory; na, not available; E, estimated value; V, analyte detected in sample and an associated blank thus data are not included in ground-water quality assessment; —, not detected; *, value is above threshold; percentage values are detection frequencies]

GAMA identification no.	Chloroform (trichloro- methane) (µg/L) (32106)	1,2-Dibromo- 3-chloro- propane (DBCP) (µg/L) (82625)	Tetrachloro- ethene (PCE) (µg/L) (34475)	<i>m</i> -Xylene plus <i>p</i> -xylene (µg/L) (85795)	Carbon disulfide (µg/L) (77041)	Bromo- dichloro- methane (µg/L) (32101)	Bromoform (tribromo- methane) (µg/L) (32104)	1,2-Dichloro- propane (µg/L) (34541)
LRL	0.020	0.030	0.06	0.06	0.04	0.028	0.10	0.03
Threshold type ¹	MCL-US	MCL-US	MCL-CA	MCL-CA	NL-CA	MCL-US	MCL-US	MCL-US
Threshold (µg/L)	² 80	0.2	0.5	1,750	160	² 80	² 80	5
Understanding Wells ³								
KINGFP-01	E0.04	*0.36	—	E0.06	—	—	—	—
KINGFP-04	E0.03	E0.05	E0.03	—	—	—	—	—
KINGFP-05	—	0.09	—	V0.05	—	—	—	—
KINGFP-07	—	—	—	—	—	—	—	—
KINGFP-08	—	*2.03	—	—	—	—	—	E0.04
KINGFP-09	—	*0.45	—	—	—	—	—	—
KINGFP-10	—	*0.2	—	—	—	—	—	—
KINGFP-11	E0.01	*1.04	—	—	—	—	—	E0.08
KINGFP-12	—	—	E0.03	—	—	—	—	—
KINGFP-13	0.14	—	—	—	—	—	—	—
KINGFP-14	—	—	—	—	—	—	—	—
KINGFP-15	—	—	—	—	—	—	—	—

Table 5. Volatile organic compounds (VOCs), gasoline oxygenates and their degradates detected in samples collected for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.—Continued

[The five-digit parameter code below the constituent name is used by the U.S. Geological Survey to uniquely identify a specific constituent or property. Samples from all 99 wells were analyzed but only samples with detections are listed. Analytes are listed in order of decreasing detection frequency in the 83 grid wells. KING, Kings study area; KWH, Kaweah study area; TULE, Tule study area; TLR, Tulare Lake study area; KINGFP, Kings study area flow-path well; µg/L, microgram per liter; LRL, laboratory reporting level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; MCL-CA, California Department of Public Health maximum contaminant level; NL-CA, California Department of Public Health notification level; HAL, U.S. Environmental Protection Agency Lifetime health advisory; na, not available; E, estimated value; V, analyte detected in sample and an associated blank thus data are not included in ground-water quality assessment; —, not detected; *, value is above threshold; percentage values are detection frequencies]

GAMA identification no.	1,2,4- Trimethyl- benzene (µg/L) (77222)	Dibromochloro- methane (µg/L) (32105)	1,1-Dichloro- ethene (DCE) (µg/L) (34501)	Trichloro- ethene (TCE) (µg/L) (39180)	Trichlorofluoro- methane (CFC-11) (µg/L) (34488)	1,1-Dichloro- ethane (µg/L) (34496)	Ethylbenzene (µg/L) (34371)	Toluene (µg/L) (34010)
LRL	0.056	0.10	0.024	0.038	0.08	0.04	0.03	0.02
Threshold type ¹	NL-CA	MCL-US	MCL-CA	MCL-CA	MCL-CA	MCL-US	MCL-CA	MCL-CA
Threshold (µg/L)	330	280	6	5	150	5	300	150
Grid wells								
KING-07	—	—	E0.03	—	—	E0.02	—	—
KING-08	—	—	—	—	—	—	—	—
KING-09	—	—	—	—	—	—	—	—
KING-10	—	—	—	—	—	—	—	—
KING-11	—	—	—	—	—	—	—	—
KING-12	—	—	—	—	—	—	—	—
KING-13	—	—	—	—	—	—	—	—
KING-15	—	—	—	—	—	—	—	—
KING-18	—	—	—	—	—	—	—	—
KING-19	—	—	—	—	—	—	—	—
KING-23	—	—	—	—	E0.04	—	—	—
KING-24	—	—	—	—	—	—	—	—
KING-26	—	—	—	—	—	—	—	V0.03
KING-29	—	—	—	E0.06	—	—	—	—
KING-34	—	—	—	—	—	—	—	—
KING-35	—	—	—	—	—	—	—	—
KING-37	—	—	—	—	—	—	—	—
KING-39	—	—	—	—	—	—	—	—
KWH-02	—	—	—	E0.03	—	—	—	—
KWH-03	—	—	—	—	—	—	—	—
KWH-05	—	—	—	—	—	—	—	—
KWH-06	—	—	—	—	E0.04	—	—	—
KWH-07	—	—	—	—	—	—	—	—
KWH-08	—	0.4	E0.07	—	—	—	—	—
KWH-09	—	—	—	—	—	—	—	—
KWH-10	—	—	—	—	—	—	—	—
KWH-12	—	—	—	—	—	—	—	—
KWH-13	—	—	—	—	—	—	—	—
KWH-14	—	—	—	—	—	—	—	—
KWH-15	—	—	—	—	—	—	—	—
KWH-16	E0.02	—	—	—	—	—	—	—
KWH-17	—	0.4	—	—	—	—	—	—
KWH-18	—	—	E0.02	—	0.54	E0.06	—	—

Table 5. Volatile organic compounds (VOCs), gasoline oxygenates and their degradates detected in samples collected for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.—Continued

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GAMA identification no.	1,2,4- Trimethyl- benzene (µg/L) (77222)	Dibromochloro- methane (µg/L) (32105)	1,1-Dichloro- ethene (DCE) (µg/L) (34501)	Trichloro- ethene (TCE) (µg/L) (39180)	Trichlorofluoro- methane (CFC-11) (µg/L) (34488)	1,1-Dichloro- ethane (µg/L) (34496)	Ethylbenzene (µg/L) (34371)	Toluene (µg/L) (34010)
LRL	0.056	0.10	0.024	0.038	0.08	0.04	0.03	0.02
Threshold type ¹	NL-CA	MCL-US	MCL-CA	MCL-CA	MCL-CA	MCL-US	MCL-CA	MCL-CA
Threshold (µg/L)	330	280	6	5	150	5	300	150
TULE-01	—	—	—	—	—	—	—	—
TULE-02	—	—	—	—	—	—	—	—
TULE-04	—	—	—	—	—	—	—	—
TULE-05	E0.02	4.1	—	—	—	—	E0.04	E0.09
TULE-06	—	—	—	—	—	—	—	—
TULE-09	—	—	—	—	—	—	—	—
TULE-10	—	—	—	—	—	—	—	—
TULE-11	—	—	—	—	—	—	—	—
TULE-12	—	—	—	—	—	—	—	—
TULE-14	—	—	—	—	—	—	—	—
TULE-16	—	—	—	—	—	—	—	V0.02
TLR-01	—	—	—	E0.05	—	—	—	—
TLR-04	E0.04	—	—	—	—	—	—	—
TLR-06	—	—	—	—	—	—	—	—
TLR-07	—	—	—	—	—	—	0.46	E0.09
TLR-08	E0.02	—	—	—	—	—	—	—
Number of detections	4	3	3	3	3	2	2	2
Detection frequency (percent)	4.8	3.6	3.6	3.6	3.6	2.4	2.4	2.4
Understanding Wells ³								
KINGFP-01	—	—	—	—	—	—	—	—
KINGFP-04	—	—	—	—	—	—	—	—
KINGFP-05	—	—	—	—	—	—	—	—
KINGFP-07	—	—	—	—	—	—	—	—
KINGFP-08	—	—	—	—	—	—	—	—
KINGFP-09	—	—	—	—	—	—	—	—
KINGFP-10	E0.02	—	—	—	—	—	—	—
KINGFP-11	—	—	—	—	—	—	—	—
KINGFP-12	—	—	—	—	—	—	—	—
KINGFP-13	—	—	—	—	—	—	—	—
KINGFP-14	—	—	—	—	—	—	—	—
KINGFP-15	—	—	—	—	—	—	—	—

Table 5. Volatile organic compounds (VOCs), gasoline oxygenates and their degradates detected in samples collected for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.—Continued

[The five-digit parameter code below the constituent name is used by the U.S. Geological Survey to uniquely identify a specific constituent or property. Samples from all 99 wells were analyzed but only samples with detections are listed. Analytes are listed in order of decreasing detection frequency in the 83 grid wells. KING, Kings study area; KWH, Kaweah study area; TULE, Tule study area; TLR, Tulare Lake study area; KINGFP, Kings study area flow-path well; µg/L, microgram per liter; LRL, laboratory reporting level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; MCL-CA; California Department of Public Health maximum contaminant level; NL-CA, California Department of Public Health notification level; HAL, U.S. Environmental Protection Agency Lifetime health advisory; na, not available; E, estimated value; V, analyte detected in sample and an associated blank thus data are not included in ground-water quality assessment; —, not detected; *, value is above threshold; percentage values are detection frequencies]

GAMA identification no.	1,1,2-Tri- chloro- trifluoro- ethane (CFC-113) (µg/L) (77652)	1,2,3-Tri- methyl- benzene (µg/L) (77221)	<i>o</i> -Xylene (µg/L) (77135)	Benzene (µg/L) (34030)	Carbon tetra- chloride (Tetra- chloro- methane) (µg/L) (32102)	Dibromo- methane (µg/L) (30217)	<i>cis</i> -1,2- Dichloro- ethene (µg/L) (77093)	Dichloro- methane (methylene chloride) (µg/L) (34423)
LRL	0.04	0.06	0.038	0.02	0.03	0.05	0.024	0.06
Threshold type ¹	MCL-US	na	MCL-CA	MCL-CA	MCL-CA	na	MCL-CA	MCL-US
Threshold (µg/L)	1,200	na	1,750	1	0.5	na	6	5
Grid wells								
KING-07	—	—	—	—	—	—	—	—
KING-08	—	—	—	—	—	—	—	—
KING-09	—	—	—	—	—	—	—	—
KING-10	—	—	—	—	—	—	—	—
KING-11	—	—	—	—	—	—	—	—
KING-12	—	—	—	—	—	—	—	—
KING-13	—	—	—	—	—	—	—	—
KING-15	—	—	—	—	—	—	—	—
KING-18	—	—	—	—	—	—	—	—
KING-19	—	—	—	—	—	—	—	—
KING-23	—	—	—	—	—	—	—	—
KING-24	—	—	—	—	—	—	—	—
KING-26	—	—	—	—	—	—	—	—
KING-29	—	—	—	—	—	—	—	—
KING-34	—	—	—	—	—	—	—	—
KING-35	—	—	—	—	—	—	—	—
KING-37	—	—	—	—	—	—	—	—
KING-39	—	—	—	—	—	—	—	—
KWH-02	—	—	—	—	—	—	—	—
KWH-03	—	—	—	—	—	—	—	—
KWH-05	—	—	—	—	—	—	—	—
KWH-06	—	—	—	—	—	—	—	—
KWH-07	—	—	—	—	—	—	—	—
KWH-08	—	—	—	—	—	—	—	—
KWH-09	—	—	—	—	—	—	—	—
KWH-10	—	—	—	—	—	—	—	—
KWH-12	—	—	—	—	—	—	—	—
KWH-13	—	—	—	—	—	—	—	—

Table 5. Volatile organic compounds (VOCs), gasoline oxygenates and their degradates detected in samples collected for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.—Continued

[The five-digit parameter code below the constituent name is used by the U.S. Geological Survey to uniquely identify a specific constituent or property. Samples from all 99 wells were analyzed but only samples with detections are listed. Analytes are listed in order of decreasing detection frequency in the 83 grid wells. KING, Kings study area; KWH, Kaweah study area; TULE, Tule study area; TLR, Tulare Lake study area; KINGFP, Kings study area flow-path well; µg/L, microgram per liter; LRL, laboratory reporting level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; MCL-CA, California Department of Public Health maximum contaminant level; NL-CA, California Department of Public Health notification level; HAL, U.S. Environmental Protection Agency Lifetime health advisory; na, not available; E, estimated value; V, analyte detected in sample and an associated blank thus data are not included in ground-water quality assessment; —, not detected; *, value is above threshold; percentage values are detection frequencies]

GAMA identification no.	1,1,2-Tri- chloro- trifluoro- ethane (CFC-113) (µg/L) (77652)	1,2,3-Tri- methyl- benzene (µg/L) (77221)	<i>o</i> -Xylene (µg/L) (77135)	Benzene (µg/L) (34030)	Carbon tetra- chloride (Tetra- chloro- methane) (µg/L) (32102)	Dibromo- methane (µg/L) (30217)	<i>cis</i> -1,2- Dichloro- ethene (µg/L) (77093)	Dichloro- methane (methylene chloride) (µg/L) (34423)
LRL	0.04	0.06	0.038	0.02	0.03	0.05	0.024	0.06
Threshold type ¹	MCL-US	na	MCL-CA	MCL-CA	MCL-CA	na	MCL-CA	MCL-US
Threshold (µg/L)	1,200	na	1,750	1	0.5	na	6	5
KWH-14	—	—	—	—	E0.05	—	—	—
KWH-15	—	—	—	—	—	—	—	—
KWH-16	—	—	—	—	—	—	—	—
KWH-17	—	—	—	—	—	—	—	—
KWH-18	E0.13	—	—	—	—	—	—	—
TULE-01	—	—	—	—	—	—	—	—
TULE-02	—	—	—	—	—	—	—	—
TULE-04	—	—	—	—	—	—	—	—
TULE-05	0.31	E0.03	E0.06	—	—	1.54	—	1.4
TULE-06	—	—	—	—	—	—	—	—
TULE-09	—	—	—	—	—	—	—	—
TULE-10	—	—	—	—	—	—	—	—
TULE-11	—	—	—	—	—	—	—	—
TULE-12	—	—	—	—	—	—	—	—
TULE-14	—	—	—	—	—	—	—	—
TULE-16	—	—	—	—	—	—	—	—
TLR-01	—	—	—	—	—	—	E0.03	—
TLR-04	—	—	—	—	—	—	—	—
TLR-06	—	—	—	—	—	—	—	—
TLR-07	—	E0.02	0.16	*78.9	—	—	—	—
TLR-08	—	—	—	—	—	—	—	—
Number of detections	2	2	2	1	1	1	1	1
Detection frequency (percent)	2.4	2.4	2.4	1.2	1.2	1.2	1.2	1.2

Table 5. Volatile organic compounds (VOCs), gasoline oxygenates and their degradates detected in samples collected for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.—Continued

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GAMA identification no.	1,1,2-Tri- chloro- trifluoro- ethane (CFC-113) (µg/L) (77652)	1,2,3-Tri- methyl- benzene (µg/L) (77221)	<i>o</i> -Xylene (µg/L) (77135)	Benzene (µg/L) (34030)	Carbon tetra- chloride (Tetra- chloro- methane) (µg/L) (32102)	Dibromo- methane (µg/L) (30217)	<i>cis</i> -1,2- Dichloro- ethene (µg/L) (77093)	Dichloro- methane (methylene chloride) (µg/L) (34423)
LRL	0.04	0.06	0.038	0.02	0.03	0.05	0.024	0.06
Threshold type¹	MCL-US	na	MCL-CA	MCL-CA	MCL-CA	na	MCL-CA	MCL-US
Threshold (µg/L)	1,200	na	1,750	1	0.5	na	6	5
Understanding Wells ³								
KINGFP-01	—	—	—	—	—	—	—	—
KINGFP-04	—	—	—	—	—	—	—	—
KINGFP-05	—	—	—	—	—	—	—	—
KINGFP-07	—	—	—	—	—	—	—	—
KINGFP-08	—	—	—	—	—	—	—	—
KINGFP-09	—	—	—	—	—	—	—	—
KINGFP-10	—	—	—	—	—	—	—	—
KINGFP-11	—	—	—	—	—	—	—	—
KINGFP-12	—	—	—	—	—	—	—	—
KINGFP-13	—	—	—	—	—	—	—	—
KINGFP-14	—	—	—	—	—	—	—	—
KINGFP-15	—	—	—	—	—	—	—	—

Table 5. Volatile organic compounds (VOCs), gasoline oxygenates and their degradates detected in samples collected for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.—Continued

[The five-digit parameter code below the constituent name is used by the U.S. Geological Survey to uniquely identify a specific constituent or property. Samples from all 99 wells were analyzed but only samples with detections are listed. Analytes are listed in order of decreasing detection frequency in the 83 grid wells. KING, Kings study area; KWH, Kaweah study area; TULE, Tule study area; TLR, Tulare Lake study area; KINGFP, Kings study area flow-path well; µg/L, microgram per liter; LRL, laboratory reporting level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; MCL-CA, California Department of Public Health maximum contaminant level; NL-CA, California Department of Public Health notification level; HAL, U.S. Environmental Protection Agency Lifetime health advisory; na, not available; E, estimated value; V, analyte detected in sample and an associated blank thus data are not included in ground-water quality assessment; —, not detected; *, value is above threshold; percentage values are detection frequencies]

GAMA identification no.	1-Ethyl- 2-methyl- benzene (<i>o</i> -Ethyl toluene) (µg/L) (77220)	Isopropyl- benzene (Cumene) (µg/L) (77223)	Methyl <i>tert</i> -butyl ether (MTBE) (µg/L) (78032)	1,2,3- Trichloro- propane (1,2,3-TCP) (µg/L) (77443)	Acetone (µg/L) (81552)	1,4- Dichloro- benzene (µg/L) (34571)	2-Butanone (Methyl ethyl ketone) (µg/L) (81595)	Tetra- hydrofuran (µg/L) (81607)	Number of detections per well
LRL	0.06	0.038	0.10	0.18	6	0.03	2	1.0	
Threshold type ¹	na	NL-CA	MCL-CA	HAL	na	MCL-CA	HAL	na	
Threshold (µg/L)	na	770	13	40	na	5	4,000	na	
KWH-14	—	—	—	—	—	—	—	—	3
KWH-15	—	—	—	—	—	—	—	—	2
KWH-16	—	—	—	—	—	—	—	—	4
KWH-17	—	—	—	—	—	—	—	—	5
KWH-18	—	—	—	—	—	—	—	—	7
TULE-01	—	—	—	—	—	—	—	—	1
TULE-02	—	—	—	—	—	—	—	—	2
TULE-04	—	—	—	—	—	—	—	—	1
TULE-05	—	—	—	—	—	—	—	—	14
TULE-06	—	—	—	—	—	—	—	—	1
TULE-09	—	—	—	—	—	—	—	—	1
TULE-10	—	—	—	—	—	—	—	—	3
TULE-11	—	—	—	—	—	—	—	—	1
TULE-12	—	—	—	—	—	—	—	—	1
TULE-14	—	—	—	—	—	—	—	—	2
TULE-16	—	—	—	—	—	—	—	—	2
TLR-01	—	—	—	—	—	—	—	—	3
TLR-04	—	—	—	—	—	—	—	—	2
TLR-06	—	—	—	—	—	—	—	—	1
TLR-07	E0.02	E0.03	—	—	—	—	—	—	8
TLR-08	—	—	—	—	—	—	—	—	1
Number of detections	1	1	1	1	0	0	0	0	⁴ 119
Detection frequency (percent)	1.2	1.2	1.2	1.2	0	0	0	0	⁵ 59

Table 5. Volatile organic compounds (VOCs), gasoline oxygenates and their degradates detected in samples collected for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.—Continued

[The five-digit parameter code below the constituent name is used by the U.S. Geological Survey to uniquely identify a specific constituent or property. Samples from all 99 wells were analyzed but only samples with detections are listed. Analytes are listed in order of decreasing detection frequency in the 83 grid wells. KING, Kings study area; KWH, Kaweah study area; TULE, Tule study area; TLR, Tulare Lake study area; KINGFP, Kings study area flow-path well; µg/L, microgram per liter; LRL, laboratory reporting level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; MCL-CA; California Department of Public Health maximum contaminant level; NL-CA, California Department of Public Health notification level; HAL, U.S. Environmental Protection Agency Lifetime health advisory; na, not available; E, estimated value; V, analyte detected in sample and an associated blank thus data are not included in ground-water quality assessment; —, not detected; *, value is above threshold; percentage values are detection frequencies]

GAMA identification no.	1-Ethyl- 2-methyl- benzene (<i>o</i> -Ethyl toluene) (µg/L) (77220)	Isopropyl- benzene (Cumene) (µg/L) (77223)	Methyl <i>tert</i> -butyl ether (MTBE) (µg/L) (78032)	1,2,3- Trichloro- propane (1,2,3-TCP) (µg/L) (77443)	Acetone (µg/L) (81552)	1,4- Dichloro- benzene (µg/L) (34571)	2-Butanone (Methyl ethyl ketone) (µg/L) (81595)	Tetra- hydrofuran (µg/L) (81607)	Number of detections per well
LRL	0.06	0.038	0.10	0.18	6	0.03	2	1.0	
Threshold type ¹	na	NL-CA	MCL-CA	HAL	na	MCL-CA	HAL	na	
Threshold (µg/L)	na	770	13	40	na	5	4,000	na	
Understanding Wells ³									
KINGFP-01	—	—	—	—	—	—	—	—	3
KINGFP-04	—	—	—	—	—	—	—	—	3
KINGFP-05	—	—	—	—	—	—	—	—	2
KINGFP-07	—	—	—	—	⁶ V6	—	⁶ V28.1	⁶ V65	0
KINGFP-08	—	—	—	—	—	—	—	—	2
KINGFP-09	—	—	—	—	—	—	—	—	1
KINGFP-10	—	—	—	—	—	—	—	—	2
KINGFP-11	—	—	—	—	—	—	—	—	3
KINGFP-12	—	—	—	*0.22	—	—	—	—	2
KINGFP-13	—	—	—	—	—	—	—	—	1
KINGFP-14	—	0.14	—	—	—	E0.08	—	—	2
KINGFP-15	—	0.19	E0.1	—	—	—	—	—	2

¹ Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists.

² The MCL-US threshold for trihalomethanes is for the sum of chloroform, bromoform, bromodichloromethane, and dibromochloromethane.

³ Non-grid wells were not included in statistical calculations.

⁴ Total number of VOC detections in grid wells.

⁵ Frequency of detection of at least one VOC in the grid wells. Detections with V remark codes are not included.

⁶ This value is V-coded because modifications to the well housing may be the source of this constituent.

Table 6A. Pesticides and (or) pesticide degradates (Schedule 2033) detected in samples collected for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.

[The five-digit parameter code below the constituent name is used by the U.S. Geological Survey to uniquely identify a specific constituent or property. Samples from all 99 wells were analyzed, but only samples with detections are listed. Analytes are listed in order of decreasing detection frequency in the 83 grid wells. KING, Kings study area; KWH, Kaweah study area; TULE, Tule study area; TLR, Tulare Lake study area; KINGFP, Kings study area flow-path well; HAL, U.S. Environmental Protection Agency Lifetime Health Advisory; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; MCL-CA, California Department of Public Health maximum contaminant level; E, estimated value; LRL, laboratory reporting level; na, not available; nc, not collected; RSD5, U.S. Environmental Protection Agency risk specific dose at a risk factor of 10^{-5} ; V, analyte detected in sample and an associated blank thus data are not included in ground-water quality assessment; $\mu\text{g/L}$, microgram per liter; —, not detected]

GAMA identification no.	Simazine ($\mu\text{g/L}$) (04035)	Deethylatrazine (2-Chloro-4- isopropylamino-6- amino- <i>s</i> -triazine) ($\mu\text{g/L}$) (04040)	Atrazine ($\mu\text{g/L}$) (39632)	3,4-Dichloro- aniline ($\mu\text{g/L}$) (61625)	Prometon ($\mu\text{g/L}$) (04037)	EPTC (<i>S</i> -Ethyl dipropylthio- carbamate) ($\mu\text{g/L}$) (82668)	3,5-Dichloro- aniline ($\mu\text{g/L}$) (61627)	Dieldrin ($\mu\text{g/L}$) 39381)	Hexazinone ($\mu\text{g/L}$) (04025)
LRL	0.005	0.006	0.007	0.0045	0.01	0.004	0.004	0.009	0.0129
Threshold Type ¹	MCL-US	na	MCL-CA	na	HAL	na	na	RSD5	HAL
Threshold ($\mu\text{g/L}$)	4	na	1	na	100	na	na	0.02	400
Grid wells									
KING-03	—	—	—	E0.004	—	—	—	—	—
KING-04	—	E0.004	—	—	—	—	—	—	—
KING-07	0.013	E0.014	0.027	E0.060	—	—	—	—	—
KING-09	0.012	—	—	—	—	—	—	—	—
KING-10	0.024	E0.021	0.014	—	—	—	—	—	—
KING-13	0.012	E0.015	E0.006	—	—	—	—	—	—
KING-16	—	E0.003	—	—	—	—	—	—	—
KING-18	0.020	E0.004	E0.007	—	E0.010	—	—	—	—
KING-19	0.011	E0.008	E0.004	E0.009	—	—	E0.006	—	—
KING-20	0.052	E0.009	E0.004	—	—	—	—	—	—
KING-22	0.009	E0.008	E0.005	—	—	—	—	E0.006	—
KING-23	—	E0.011	E0.006	—	—	—	—	—	—
KING-24	0.012	—	0.015	—	—	—	—	—	—
KING-25	0.009	E0.004	E0.006	—	—	—	—	—	—
KING-28	0.008	—	—	—	—	—	—	—	—
KING-29	0.009	—	—	E0.006	—	—	—	—	—
KING-32	0.008	—	—	—	—	—	—	—	—
KING-34	E0.004	—	—	—	—	—	—	—	—
KING-37	0.087	E0.006	0.010	E0.005	—	—	E0.004	—	—
KING-39	—	—	—	E0.020	—	0.038	—	—	E0.013
KWH-01	0.015	E0.008	E0.004	—	—	—	—	—	—
KWH-02	0.073	E0.008	—	—	—	—	—	—	—
KWH-03	0.021	E0.004	E0.007	—	—	—	—	—	—
KWH-04	0.023	E0.003	—	E0.001	—	—	—	—	—
KWH-05	0.111	E0.014	E0.008	E0.002	E0.010	—	—	—	—
KWH-06	0.014	E0.012	0.009	E0.001	E0.004	—	—	—	—
KWH-07	0.045	E0.008	—	—	E0.004	—	—	—	—
KWH-08	0.008	E0.003	—	—	—	—	—	—	—
KWH-09	0.017	E0.004	E0.007	—	—	—	—	—	—
KWH-10	0.024	E0.007	0.009	—	—	—	—	—	—

Table 6A. Pesticides and (or) pesticide degradates (Schedule 2033) detected in samples collected for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.—Continued

[The five-digit parameter code below the constituent name is used by the U.S. Geological Survey to uniquely identify a specific constituent or property. Samples from all 99 wells were analyzed, but only samples with detections are listed. Analytes are listed in order of decreasing detection frequency in the 83 grid wells. KING, Kings study area; KWH, Kaweah study area; TULE, Tule study area; TLR, Tulare Lake study area; KINGFP, Kings study area flow-path well; HAL, U.S. Environmental Protection Agency Lifetime Health Advisory; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; MCL-CA; California Department of Public Health maximum contaminant level; E, estimated value; LRL, laboratory reporting level; na, not available; nc, not collected; RSD5, U.S. Environmental Protection Agency risk specific dose at a risk factor of 10^{-5} ; V, analyte detected in sample and an associated blank thus data are not included in ground-water quality assessment; $\mu\text{g/L}$, microgram per liter; —, not detected]

GAMA identification no.	Simazine ($\mu\text{g/L}$) (04035)	Deethylatrazine (2-Chloro-4- isopropylamino-6- amino- <i>s</i> -triazine) ($\mu\text{g/L}$) (04040)	Atrazine ($\mu\text{g/L}$) (39632)	3,4-Dichloro- aniline ($\mu\text{g/L}$) (61625)	Prometon ($\mu\text{g/L}$) (04037)	EPTC (<i>S</i> -Ethyl dipropylthio- carbamate) ($\mu\text{g/L}$) (82668)	3,5-Dichloro- aniline ($\mu\text{g/L}$) (61627)	Dieldrin ($\mu\text{g/L}$) 39381)	Hexazinone ($\mu\text{g/L}$) (04025)
LRL	0.005	0.006	0.007	0.0045	0.01	0.004	0.004	0.009	0.0129
Threshold Type ¹	MCL-US	na	MCL-CA	na	HAL	na	na	RSD5	HAL
Threshold ($\mu\text{g/L}$)	4	na	1	na	100	na	na	0.02	400
KWH-11	0.008	E0.003	E0.007	—	—	—	—	—	—
KWH-12	0.026	E0.006	0.021	—	E0.005	—	—	—	—
KWH-14	0.103	E0.011	0.017	—	—	—	—	—	—
KWH-15	0.008	—	—	—	—	—	—	—	—
KWH-16	0.009	—	—	E0.002	—	—	—	—	—
KWH-17	E0.007	—	—	—	—	—	—	—	—
KWH-18	0.023	E0.010	0.009	E0.006	—	—	—	—	—
TULE-02	0.008	E0.005	E0.005	—	—	—	—	—	—
TULE-03	E0.005	—	—	—	—	—	—	—	—
TULE-05	0.008	E0.005	0.009	—	—	—	—	—	—
TULE-09	—	E0.009	0.009	—	—	—	—	—	—
TULE-10	0.019	E0.007	0.009	E0.006	—	0.039	—	—	E0.010
TULE-13	E0.007	—	—	—	—	—	—	—	—
TULE-14	—	—	—	—	—	E0.004	—	—	—
TULE-16	0.138	E0.005	—	—	—	—	—	E0.003	—
TLR-01	E0.007	E0.005	E0.006	—	—	—	—	—	—
Number of detections	39	32	26	12	5	3	2	2	2
Detection Frequency	47	39	31	14	6.0	3.6	2.4	2.4	2.4
Understanding wells									
KINGFP-01	0.025	E0.014	—	E0.009	—	—	—	—	—
KINGFP-04	0.009	E0.004	—	E0.001	—	—	—	—	—
KINGFP-05	0.014	E0.01	E0.005	—	—	—	—	—	—
KINGFP-07	sample ruined	E0.02	0.01	sample ruined	sample ruined	sample ruined	sample ruined	sample ruined	sample ruined
KINGFP-08	0.042	E0.004	E0.008	E0.019	—	—	—	—	—
KINGFP-10	—	E0.003	—	—	—	—	—	—	—
KINGFP-11	0.048	E0.005	E0.007	E0.001	—	—	E0.002	—	—
KINGFP-12	0.044	E0.007	—	—	—	—	—	—	—
KINGFP-14	—	—	—	E0.288	—	—	—	—	—
KINGFP-15	0.027	—	—	E0.082	—	—	—	—	—

Table 6A. Pesticides and (or) pesticide degradates (Schedule 2033) detected in samples collected for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.—Continued

[The five-digit parameter code below the constituent name is used by the U.S. Geological Survey to uniquely identify a specific constituent or property. Samples from all 99 wells were analyzed, but only samples with detections are listed. Analytes are listed in order of decreasing detection frequency in the 83 grid wells. KING, Kings study area; KWH, Kaweah study area; TULE, Tule study area; TLR, Tulare Lake study area; KINGFP, Kings study area flow-path well; HAL, U.S. Environmental Protection Agency Lifetime Health Advisory; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; MCL-CA; California Department of Public Health maximum contaminant level; E, estimated value; LRL, laboratory reporting level; na, not available; nc, not collected; RSD5, U.S. Environmental Protection Agency risk specific dose at a risk factor of 10^{-5} ; V, analyte detected in sample and an associated blank thus data are not included in ground-water quality assessment; $\mu\text{g/L}$, microgram per liter; —, not detected]

GAMA identification no.	Aceto-chlor ($\mu\text{g/L}$) (49260)	Alachlor ($\mu\text{g/L}$) (46342)	Diazinon ($\mu\text{g/L}$) (39572)	Metola-chlor ($\mu\text{g/L}$) (39415)	1-Naphthol ($\mu\text{g/L}$) (49295)	Desulfinyl fipronil ($\mu\text{g/L}$) (62170)	Fipronil sulfide ($\mu\text{g/L}$) (62167)	Myclobutanil ($\mu\text{g/L}$) (61599)	Prometryn ($\mu\text{g/L}$) (04036)	Number of detect- ions per well
LRL	0.006	0.005	0.005	0.006	0.0882	0.012	0.013	0.008	0.0054	
Threshold Type ¹	na	MCL-US	HAL	HAL	na	na	na	na	na	
Threshold ($\mu\text{g/L}$)	na	2	1	700	na	na	na	na	na	
KWH-11	—	—	—	—	—	—	—	—	—	3
KWH-12	—	—	—	—	—	—	—	—	—	4
KWH-14	—	—	—	—	—	—	—	—	—	3
KWH-15	—	—	—	—	—	—	—	—	—	1
KWH-16	—	—	—	—	—	—	—	—	—	2
KWH-17	—	—	—	—	—	—	—	—	—	1
KWH-18	—	—	—	—	—	—	—	—	—	4
TULE-02	—	—	—	—	—	—	—	—	—	3
TULE-03	—	—	—	—	—	—	—	—	—	1
TULE-05	—	—	—	—	—	—	—	—	—	3
TULE-09	—	—	—	—	—	—	—	—	—	2
TULE-10	—	—	—	—	—	—	—	—	—	6
TULE-13	—	—	—	—	—	—	—	—	—	1
TULE-14	—	—	—	—	—	—	—	—	—	1
TULE-16	—	—	—	—	—	—	—	—	—	3
TLR-01	—	—	—	—	—	—	—	—	—	3
Number of detections	1	1	1	1	1	0	0	0	0	² 128
Detection Frequency	1.2	1.2	1.2	1.2	1.2	0	0	0	0	³ 55
Understanding wells										
KINGFP-01	—	—	—	—	—	—	—	—	—	3
KINGFP-04	—	—	—	—	—	—	—	—	—	3
KINGFP-05	—	—	—	—	—	—	—	—	—	3
KINGFP-07	sample ruined	sample ruined	sample ruined	sample ruined	sample ruined	sample ruined	sample ruined	sample ruined	sample ruined	2
KINGFP-08	—	—	—	—	—	—	—	—	—	4
KINGFP-10	—	—	—	—	—	—	—	—	—	1
KINGFP-11	—	—	—	—	—	—	—	—	—	5
KINGFP-12	—	—	—	—	—	—	—	—	—	2
KINGFP-14	—	—	—	—	—	E0.005	E0.006	0.034	E0.006	5
KINGFP-15	—	—	—	—	—	E0.005	E0.006	—	—	4

¹ Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists.

² Total number of pesticide detections in grid wells.

³ Frequency of detection of at least one pesticide or pesticide degradate in the grid wells.

Table 6B. Polar pesticides and (or) pesticide degradates and caffeine (Schedule 2060) detected in samples collected for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.

[The five-digit parameter code below the constituent name is used by the U.S. Geological Survey to uniquely identify a specific constituent or property. Samples from 44 intermediate and slow wells were analyzed, but only samples with detections are listed. Analytes are listed in order of decreasing detection frequency. KING, Kings study area; KWH, Kaweah study area; TULE, Tule study area; TLR, Tulare Lake study area; KINGFP, Kings study area flow-path well; HAL, U.S. Environmental Protection Agency Lifetime Health Advisory; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; MCL-CA, California Department of Public Health maximum contaminant level; E, estimated value; LRL, laboratory reporting level; na, not available; RSD5, U.S. Environmental Protection Agency risk-specific dose at a risk factor of 10^{-5} ; V, analyte detected in sample and an associated blank, thus data are not included in ground-water quality assessment; $\mu\text{g/L}$, microgram per liter; —, not detected]

GAMA identification no.	Caffeine ($\mu\text{g/L}$) (50305)	Deisopropyl atrazine (2-Chloro-6- ethylamino-4- amino- <i>s</i> -triazine) ($\mu\text{g/L}$) (04038)	Metsulfuron methyl ($\mu\text{g/L}$) (61697)	Bromacil ($\mu\text{g/L}$) (04029)	Dinoseb ($\mu\text{g/L}$) (49301)	Diuron ($\mu\text{g/L}$) (49300)
LRL	0.018	0.08	0.025	0.018	0.038	0.015
Threshold Type¹	na	na	na	HAL	MCL-CA	RSD5
Threshold ($\mu\text{g/L}$)	na	na	na	70	7	20
Grid wells						
KING-04	0.024	E0.005	—	—	—	—
KING-09	0.023	E0.01	—	—	—	—
KING-10	E0.011	E0.05	—	—	—	—
KING-12	—	E0.01	—	—	—	—
KING-13	0.02	—	—	—	—	—
KING-15	V0.01	—	—	—	—	—
KING-16	V0.009	—	—	—	—	—
KING-20	V0.01	E0.18	—	E0.01	—	—
KING-30	0.023	—	—	—	—	—
KWH-03	—	E0.03	—	—	—	—
KWH-06	E0.006	E0.02	—	—	—	0.02
KWH-11	E0.005	—	—	—	—	—
KWH-12	—	E0.03	E0.07	E0.01	E0.003	—
KWH-14	—	E0.10	E0.07	—	—	E0.02
TULE-01	—	—	E0.07	—	—	—
TULE-03	—	E0.004	E0.07	—	—	—
TLR-02	—	—	E0.07	—	—	—
TLR-04	—	—	E0.07	—	—	—
TLR-05	E0.004	—	E0.07	—	—	—
TLR-06	E0.007	—	E0.07	—	—	—
TLR-08	E0.011	—	—	E0.01	—	—
Number of detections	10	10	8	3	2	2
Detection Frequency	36	36	31	11	7.1	7.1
Understanding wells						
KINGFP-01	—	E0.2	—	0.91	—	0.25
KINGFP-02	V0.004	—	—	—	—	—
KINGFP-04	E0.008	E0.01	—	—	—	0.03
KINGFP-05	—	E0.06	—	—	—	—
KINGFP-07	—	E0.3	—	—	—	—
KINGFP-08	—	0.3	—	0.54	—	0.67

Table 6B. Polar pesticides and (or) pesticide degradates and caffeine (Schedule 2060) detected in samples collected for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.—Continued

[The five-digit parameter code below the constituent name is used by the U.S. Geological Survey to uniquely identify a specific constituent or property. Samples from 44 intermediate and slow wells were analyzed, but only samples with detections are listed. Analytes are listed in order of decreasing detection frequency. KING, Kings study area; KWH, Kaweah study area; TULE, Tule study area; TLR, Tulare Lake study area; KINGFP, Kings study area flow-path well; HAL, U.S. Environmental Protection Agency Lifetime Health Advisory; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; MCL-CA, California Department of Public Health maximum contaminant level; E, estimated value; LRL, laboratory reporting level; na, not available; RSD5, U.S. Environmental Protection Agency risk-specific dose at a risk factor of 10^{-5} ; V, analyte detected in sample and an associated blank, thus data are not included in ground-water quality assessment; µg/L, microgram per liter; —, not detected]

GAMA identification no.	Caffeine (µg/L) (50305)	Deisopropyl atrazine (2-Chloro-6- ethylamino-4- amino-<i>s</i>-triazine) (µg/L) (04038)	Metsulfuron methyl (µg/L) (61697)	Bromacil (µg/L) (04029)	Dinoseb (µg/L) (49301)	Diuron (µg/L) (49300)
LRL	0.018	0.08	0.025	0.018	0.038	0.015
Threshold Type¹	na	na	na	HAL	MCL-CA	RSD5
Threshold (µg/L)	na	na	na	70	7	20
KINGFP-10	—	E0.01	—	E0.01	—	—
KINGFP-11	V0.007	E0.32	—	—	—	0.03
KINGFP-12	—	E0.29	—	—	—	0.17
KINGFP-13	V0.012	—	—	—	—	—
KINGFP-14	—	—	—	—	—	E0.54
KINGFP-15	—	—	—	—	—	E0.44

Table 6B. Polar pesticides and (or) pesticide degradates and caffeine (Schedule 2060) detected in samples collected for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.—Continued

[The five-digit parameter code below the constituent name is used by the U.S. Geological Survey to uniquely identify a specific constituent or property. Samples from 44 intermediate and slow wells were analyzed, but only samples with detections are listed. Analytes are listed in order of decreasing detection frequency. KING, Kings study area; KWH, Kaweah study area; TULE, Tule study area; TLR, Tulare Lake study area; KINGFP, Kings study area flow-path well; HAL, U.S. Environmental Protection Agency Lifetime Health Advisory; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; MCL-CA, California Department of Public Health maximum contaminant level; E, estimated value; LRL, laboratory reporting level; na, not available; RSD5, U.S. Environmental Protection Agency risk-specific dose at a risk factor of 10^{-5} ; V, analyte detected in sample and an associated blank, thus data are not included in ground-water quality assessment; $\mu\text{g/L}$, microgram per liter; —, not detected]

GAMA identification no.	Fenuron ($\mu\text{g/L}$) (49297)	Bentazon ($\mu\text{g/L}$) (38711)	Deethyldeisopropyl atrazine (chlorodiamino-s- triazine) ($\mu\text{g/L}$) (04039)		Oxamyl ($\mu\text{g/L}$) (38866)	Number of detections per well
			Imazethapyr ($\mu\text{g/L}$) (50407)			
LRL	0.019	0.012	0.04	0.038	0.030	
Threshold Type¹	na	MCL-CA	na	na	MCL-CA	
Threshold ($\mu\text{g/L}$)	na	18	na	na	50	
Grid wells						
KING-04	—	—	—	—	—	2
KING-09	—	—	—	—	—	2
KING-10	—	—	—	—	—	2
KING-12	—	—	—	—	—	1
KING-13	—	—	—	—	—	1
KING-15	—	—	—	—	—	0
KING-16	—	—	—	—	—	0
KING-20	—	—	—	—	—	2
KING-30	—	—	—	—	—	1
KWH-03	—	—	—	—	—	1
KWH-06	—	—	—	—	—	3
KWH-11	0.02	—	—	—	—	1
KWH-12	—	—	—	—	—	3
KWH-14	—	—	—	—	—	2
TULE-01	—	—	—	—	—	0
TULE-03	—	—	—	—	—	1
TLR-02	—	—	—	—	—	0
TLR-04	—	—	—	—	—	0
TLR-05	—	—	—	—	—	1
TLR-06	—	—	—	—	—	1
TLR-08	—	—	—	—	—	2
Number of detections	1	0	0	0	0	² 26
Detection Frequency	3.6	0	0	0	0	³ 57
Understanding wells						
KINGFP-01	—	E0.01	E0.06	—	—	5
KINGFP-02	—	—	—	—	—	0
KINGFP-04	—	—	—	—	—	3
KINGFP-05	—	—	—	—	—	1
KINGFP-07	—	—	E0.07	—	—	2
KINGFP-08	—	—	E0.08	—	E0.03	5

Table 6B. Polar pesticides and (or) pesticide degradates and caffeine (Schedule 2060) detected in samples collected for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.—Continued

[The five-digit parameter code below the constituent name is used by the U.S. Geological Survey to uniquely identify a specific constituent or property. Samples from 44 intermediate and slow wells were analyzed, but only samples with detections are listed. Analytes are listed in order of decreasing detection frequency. KING, Kings study area; KWH, Kaweah study area; TULE, Tule study area; TLR, Tulare Lake study area; KINGFP, Kings study area flow-path well; HAL, U.S. Environmental Protection Agency Lifetime Health Advisory; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; MCL-CA, California Department of Public Health maximum contaminant level; E, estimated value; LRL, laboratory reporting level; na, not available; RSD5, U.S. Environmental Protection Agency risk-specific dose at a risk factor of 10^{-5} ; V, analyte detected in sample and an associated blank, thus data are not included in ground-water quality assessment; $\mu\text{g/L}$, microgram per liter; —, not detected]

GAMA identification no.	Fenuron ($\mu\text{g/L}$) (49297)	Bentazon ($\mu\text{g/L}$) (38711)	Deethyldeisopropyl atrazine (chlorodiamino-s- triazine) ($\mu\text{g/L}$) (04039)		Oxamyl ($\mu\text{g/L}$) (38866)	Number of detections per well
			Imazethapyr ($\mu\text{g/L}$) (50407)			
LRL	0.019	0.012	0.04	0.038	0.030	
Threshold Type¹	na	MCL-CA	na	na	MCL-CA	
Threshold ($\mu\text{g/L}$)	na	18	na	na	50	
KINGFP-10	—	—	—	—	—	2
KINGFP-11	—	—	E0.18	—	—	3
KINGFP-12	—	—	E0.22	—	—	3
KINGFP-13	—	—	—	—	—	0
KINGFP-14	—	—	—	—	—	1
KINGFP-15	—	—	—	0.43	—	2

¹ Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists.

² Total number of pesticide detections in grid wells.

³ Frequency of detection of at least one pesticide or pesticide degradate in the grid wells (not including caffeine).

Table 7. Constituents of special interest [Perchlorate, *N*-Nitrosodimethylamine (NDMA), and 1,2,3-Trichloropropane (1,2,3-TCP)] detected in samples collected in the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.

[The five-digit parameter code below the constituent name is used by the U.S. Geological Survey to uniquely identify a specific constituent or property. Analyses done by the Montgomery Watson Harza laboratory. Samples from all 99 wells were analyzed for perchlorate, samples from the 44 intermediate and slow wells were sampled for NDMA and 1,2,3-TCP; only wells with at least one detection are listed. KING, Kings study area; KWH, Kaweah study area; TULE, Tule study area; KINGFP, Kings study area flow-path well; MCL-CA, California Department of Public Health defined maximum contaminant level; NL-CA, California Department of Public Health notification level; HAL, U.S. Environmental Protection Agency Lifetime health advisory; MRL, minimum reporting level; µg/L, microgram per liter; —, not detected; nc, not collected; *, value is above threshold]

GAMA identification no.	Perchlorate (µg/L) (61209)	<i>N</i> -Nitrosodimethylamine (NDMA) (µg/L) (64176)	1,2,3-Trichloropropane (µg/L) (77443)
MRL	0.5	0.002	0.005
Threshold type	MCL-CA	NL-CA	HAL
Threshold (µg/L)	6	0.010	40
Grid wells			
KING-11	0.94	—	—
KING-12	1.5	—	—
KING-13	0.62	—	—
KING-15	0.71	—	—
KING-34	0.62	nc	nc
KING-35	0.89	nc	nc
KWH-04	0.71	nc	nc
KWH-05	1.8	nc	nc
KWH-06	*10	—	—
KWH-08	2.2	nc	nc
KWH-09	0.71	nc	nc
KWH-10	2.7	nc	nc
KWH-11	—	0.0062	—
KWH-12	—	—	0.008
KWH-13	1.1	nc	nc
KWH-18	0.63	nc	nc
TULE-10	0.64	nc	nc
TULE-14	0.94	nc	nc
Number of wells with detections	16	1	1
Detection frequency (percent)	19	2.2	2.2
Understanding wells			
KINGFP-01	1.9	—	—
KINGFP-02	—	0.0033	—
KINGFP-03	0.52	—	—
KINGFP-04	0.86	—	—
KINGFP-05	0.95	—	0.009
KINGFP-07	1.7	—	—
KINGFP-08	1.1	—	0.045
KINGFP-09	0.73	—	0.010
KINGFP-10	—	—	0.017
KINGFP-11	3.9	—	0.43
KINGFP-12	5.8	—	0.29
KINGFP-13	0.91	—	—

Table 8. Nutrients and dissolved organic carbon detected in samples collected for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.

[The five-digit parameter code below the constituent name is used by the U.S. Geological Survey to uniquely identify a specific constituent or property. Samples from the 44 intermediate and slow wells were analyzed. KING, Kings study area; KWH, Kaweah study area; TULE, Tule study area; TLR, Tulare Lake study area; KINGFP, Kings study area flow-path well; HWY99T, Highway 99 transect well; HAL, U.S. Environmental Protection Agency Lifetime Health Advisory Level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; LRL, laboratory reporting level; mg/L, milligram per liter; na, not available; E, estimated value; nc, not collected; V, analyte detected in sample and an associated blank, thus data are not included in ground-water quality assessment; *, value is above threshold; —, not detected]

GAMA identification no.	Ammonia, as nitrogen (mg/L) (00608)	Nitrite plus nitrate, as nitrogen (mg/L) (00631)	Nitrite, as nitrogen (mg/L) (00613)	Total nitrogen (nitrate + nitrite + ammonia + organic-nitrogen), as nitrogen (mg/L) (62854)	Orthophosphate, as phosphorous (mg/L) (00671)	Dissolved organic carbon (mg/L) (00681)
LRL	0.04	0.06	0.008	0.03	0.006	0.3
Threshold Type ¹	HAL	MCL-US	MCL-US	na	na	na
Threshold (mg/L)	² 24.7	10	1	na	na	na
Grid wells						
KING-04	—	2.53	E0.006	³ 2.49	0.015	0.3
KING-09	—	1.79	—	1.82	0.006	nc
KING-10	—	1.69	—	1.69	0.006	nc
KING-11	—	4.09	—	³ 3.94	0.014	nc
KING-12	—	8.24	—	³ 7.95	0.030	nc
KING-13	—	3.21	—	3.29	0.020	nc
KING-15	—	6.95	—	³ 6.75	0.035	nc
KING-16	—	2.09	—	2.20	0.048	nc
KING-17	—	4.80	—	³ 4.76	0.014	0.4
KING-20	—	1.01	—	1.05	0.078	V0.3
KING-25	—	5.14	—	5.26	0.006	nc
KING-30	—	2.75	—	³ 2.71	0.024	nc
KING-38	—	2.45	—	2.51	0.011	nc
KWH-03	—	2.65	—	2.65	—	nc
KWH-06	—	9.13	—	9.20	0.007	nc
KWH-11	—	—	—	—	0.042	nc
KWH-12	—	3.26	—	3.37	—	V0.2
KWH-14	—	2.71	—	2.72	—	0.6
TULE-01	—	3.37	—	³ 3.27	0.006	—
TULE-03	—	2.30	—	2.29	0.020	nc
TULE-07	—	2.34	—	2.54	E0.005	nc
TULE-08	—	0.43	—	0.42	0.028	V0.2
TULE-17	—	1.75	—	1.80	0.006	nc
TLR-02	0.23	—	—	0.38	0.054	nc
TLR-04	—	—	—	—	0.021	—
TLR-05	E0.03	—	—	0.07	0.105	1.3
TLR-06	1.23	—	—	1.35	0.154	nc
TLR-08	E0.02	—	—	0.06	0.032	nc

Table 8. Nutrients and dissolved organic carbon detected in samples collected for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.—Continued

[The five-digit parameter code below the constituent name is used by the U.S. Geological Survey to uniquely identify a specific constituent or property. Samples from the 44 intermediate and slow wells were analyzed. KING, Kings study area; KWH, Kaweah study area; TULE, Tule study area; TLR, Tulare Lake study area; KINGFP, Kings study area flow-path well; HWY99T, Highway 99 transect well; HAL, U.S. Environmental Protection Agency Lifetime Health Advisory Level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; LRL, laboratory reporting level; mg/L, milligram per liter; na, not available; E, estimated value; nc, not collected; V, analyte detected in sample and an associated blank, thus data are not included in ground-water quality assessment; *, value is above threshold; —, not detected]

GAMA identification no.	Ammonia, as nitrogen (mg/L) (00608)	Nitrite plus nitrate, as nitrogen (mg/L) (00631)	Nitrite, as nitrogen (mg/L) (00613)	Total nitrogen (nitrate + nitrite + ammonia + organic-nitrogen), as nitrogen (mg/L) (62854)	Orthophosphate, as phosphorous (mg/L) (00671)	Dissolved organic carbon (mg/L) (00681)
LRL	0.04	0.06	0.008	0.03	0.006	0.3
Threshold Type¹	HAL	MCL-US	MCL-US	na	na	na
Threshold (mg/L)	²24.7	10	1	na	na	na
Understanding wells						
KINGFP-01	—	*12.1	—	12.3	0.017	0.5
KINGFP-02	—	2.82	—	2.82	0.020	—
KINGFP-03	—	3.54	—	³ 3.43	0.016	—
KINGFP-04	—	6.41	—	³ 6.14	0.025	0.3
KINGFP-05	—	7.17	—	7.31	0.040	nc
KINGFP-06	—	2.38	—	2.40	0.026	nc
KINGFP-07	—	*25.8	—	³ 24.5	0.051	nc
KINGFP-08	—	*12.8	—	³ 12.6	0.049	nc
KINGFP-09	—	2.80	—	³ 2.68	0.059	nc
KINGFP-10	—	2.44	—	2.45	0.039	nc
KINGFP-11	—	*10.3	—	³ 9.17	0.045	nc
KINGFP-12	—	*34.3	—	³ 32.5	0.030	nc
KINGFP-13	—	*10.3	—	³ 10.0	0.029	nc
KINGFP-14	8.10	—	—	8.06	1.34	nc
KINGFP-15	0.73	—	—	0.88	1.56	nc
HWY99T-01	—	1.76	—	1.75	0.023	nc

¹ Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists.

² Total nitrogen in these samples is less than the sum of the filtered nitrogen analytes, but falls within the U.S. Geological Survey National Water Quality Laboratory acceptance criteria of 10 percent relative percent difference.

³ The published HAL for ammonia is 30 mg/L as NH₃; using molar mass ratios, the HAL can be converted for ammonia as nitrogen. This value is 24.7 mg/L.

Table 9. Major and minor ions and total dissolved solids detected in samples collected for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.

[The five-digit parameter code below the constituent name is used by the U.S. Geological Survey to uniquely identify a specific constituent or property. Samples from the 44 intermediate and slow wells were analyzed. KING, Kings study area; KWH, Kaweah study area; TULE, Tule study area; KINGFP, Kings study area flow-path well; HWY99T, Highway 99 transect well; LRL, laboratory reporting level; MCL-CA, California Department of Public Health maximum contaminant level; SMCL-CA, California Department of Public Health secondary maximum contaminant level; E, estimated value; na, not available; mg/L, milligram per liter; —, not detected; *, value is above threshold value]

GAMA Identification no.	Calcium, filtered (mg/L) (00915)	Magnesium, filtered (mg/L) (00925)	Potassium, filtered (mg/L) (00935)	Sodium, filtered (mg/L) (00930)	Bicarbonate ¹ , dissolved (mg/L as HCO ₃ ⁻) (63786)	Carbonate ¹ , dissolved (mg/L as CO ₃ ²⁻) (63788)	Bromide, filtered (mg/L) (71870)	Chloride, filtered (mg/L) (00940)	Fluoride, filtered (mg/L) (00950)	Iodide, filtered (mg/L) (71865)	Silica, filtered (mg/L) (00955)	Sulfate, filtered (mg/L) (00945)	Total dissolved solids (residue on evaporation) (mg/L) (70300)
	0.02	0.008	0.16	0.2	1	1	0.02	0.2	0.1	0.002	0.04	0.18	10
Threshold type ²	na	na	na	na	na	na	na	SMCL-CA 250 (500) ³	MCL-CA 2	na	na	SMCL-CA 250 (500) ³	SMCL-CA 500 (1,000) ³
Threshold (mg/L)	na	na	na	na	na	na	na	na	na	na	na	na	na
Grid wells													
KING-04	17.9	1.09	7.24	86.9	170	1.4	0.15	60.7	0.21	0.016	62.4	22.4	364
KING-09	16.3	0.279	1.56	19.6	nc	nc	0.05	14.5	E0.07	—	15.4	8.48	111
KING-10	31.9	4.67	2.46	19.8	nc	nc	0.05	11.3	E0.09	E0.001	27.3	8.76	173
KING-11	33.9	15.4	2.10	31.4	nc	nc	0.10	32.4	0.14	0.002	36.6	7.55	263
KING-12	56.7	22.0	3.38	25.6	nc	nc	0.07	13.6	0.20	E0.001	62.6	34.6	373
KING-13	28.6	10.7	2.32	24.3	nc	nc	0.06	13.5	0.15	E0.002	47.0	5.30	224
KING-15	27.4	18.0	6.55	21.5	nc	nc	0.08	15.4	0.11	E0.003	74.8	7.50	272
KING-16	15.8	8.39	3.40	11.9	nc	nc	0.03	4.38	0.15	—	64.7	4.07	173
KING-17	23.3	12.3	3.51	26.0	159	0.6	0.05	10.9	0.16	E0.001	39.7	4.30	200
KING-20	9.86	6.54	1.47	6.51	65	0.1	E 0.01	1.72	E0.05	—	26.2	7.94	91
KING-25	40.4	14.9	3.01	39.6	nc	nc	0.16	56.5	0.17	0.002	49.0	13.3	328
KING-30	20.0	4.34	1.67	29.9	nc	nc	0.05	8.79	E0.09	—	20.1	6.97	162
KING-38	16.1	6.99	1.95	39.9	nc	nc	0.05	6.62	0.18	—	25.8	6.08	184
KWH-03	30.8	1.31	1.12	12.6	nc	nc	0.03	6.21	E0.05	—	19.3	13.1	143
KWH-06	71.1	37.4	4.22	64.2	nc	nc	0.36	200	0.12	0.011	34.9	28.3	*554
KWH-11	1.79	0.040	0.30	75.6	nc	nc	0.05	18.7	1.38	0.062	14.3	6.65	202
KWH-12	17.4	0.549	1.36	27.8	78	0.8	0.04	8.61	E0.10	—	15.0	12.9	144
KWH-14	33.1	1.33	1.32	33.8	129	0.4	0.07	19.7	E0.06	E0.001	17.7	10.5	197
TULE-01	10.6	0.497	1.04	43.4	65	2.1	0.07	15.9	0.20	E0.001	26.5	18.3	165
TULE-03	14.4	1.19	0.17	49.2	nc	nc	0.02	6.93	0.27	0.005	25.1	13.5	190
TULE-07	6.00	0.192	0.22	53.3	nc	nc	0.03	10.6	0.19	0.006	16.0	12.0	168
TULE-08	1.22	V0.01	0.21	42.4	58	14.9	0.03	6.91	0.34	0.006	17.7	8.51	119
TULE-17	23.6	1.65	0.52	27.6	nc	nc	0.07	15.3	0.24	—	53.0	13.2	192

Table 9. Major and minor ions and total dissolved solids detected in samples collected for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.—Continued

[The five-digit parameter code below the constituent name is used by the U.S. Geological Survey to uniquely identify a specific constituent or property. Samples from the 44 intermediate and slow wells were analyzed. KING, Kings study area; KWH, Kaweah study area; TULE, Tule study area; KINGFP, Kings study area flow-path well; HWY99T, Highway 99 transect well; LRL, laboratory reporting level; MCL-CA, California Department of Public Health maximum contaminant level; SMCL-CA, California Department of Public Health secondary maximum contaminant level; E, estimated value; na, not available; mg/L, milligram per liter; —, not detected; *, value is above threshold value]

GAMA Identification no.	Calcium, filtered (mg/L) (00915)	Magnesium, filtered (mg/L) (00925)	Potassium, filtered (mg/L) (00935)	Sodium, filtered (mg/L) (00930)	Bicarbonate ¹ , dissolved (mg/L as HCO ₃ ⁻) (63786)	Carbonate ¹ , dissolved (mg/L as CO ₃ ²⁻) (63788)	Bromide, filtered (mg/L) (71870)	Chloride, filtered (mg/L) (00940)	Fluoride, filtered (mg/L) (00950)	Iodide, filtered (mg/L) (71865)	Silica, filtered (mg/L) (00955)	Sulfate, filtered (mg/L) (00945)	Total dissolved solids (residue on evaporation) (mg/L) (70300)
	0.02	0.008	0.16	0.2	1	1	0.02	0.2	0.1	0.002	0.04	0.18	10
Threshold type ²	na	na	na	na	na	na	na	na	na	na	na	na	na
Threshold (mg/L)	na	na	na	na	na	na	na	SMCL-CA 250 (500) ³	MCL-CA 2	na	na	SMCL-CA 250 (500) ³	SMCL-CA 500 (1,000) ³
TLR-02	1.46	0.075	0.39	99.4	nc	nc	0.08	19.9	1.87	0.048	18.1	0.31	252
TLR-04	3.57	0.315	0.76	154	151	5.5	0.45	157	1.23	0.427	15.2	—	415
TLR-05	0.87	0.025	0.42	90.0	147	14.8	0.10	35.0	1.56	0.096	33.0	1.19	260
TLR-06	14.8	3.60	1.76	269	nc	nc	0.25	86.8	0.40	0.101	31.3	*282	853
TLR-08	8.56	0.253	0.86	71.3	nc	nc	0.06	15.8	0.23	0.037	59.6	13.8	261
Understanding wells													
KINGFP-01	79.5	44.0	3.53	36.3	299	0.7	0.27	37.0	0.12	0.003	42.6	64.2	*543
KINGFP-02	17.6	7.00	1.73	38.7	158	1.1	0.05	11.0	0.14	E0.001	21.6	3.64	190
KINGFP-03	15.4	5.20	1.62	36.7	138	1.3	0.06	9.72	0.15	E0.001	23.1	3.57	181
KINGFP-04	44.8	31.6	4.73	19.9	234	0.5	0.06	12.2	0.11	0.003	62.9	23.5	332
KINGFP-05	61.8	49.0	4.02	41.7	376	0.5	0.13	18.7	0.12	0.025	48.7	64.8	*501
KINGFP-06	25.7	21.9	2.56	20.6	E208	E2.1	0.05	8.30	E0.09	—	43.7	5.93	233
KINGFP-07	105	39.1	4.21	61.2	372	0.2	0.31	24.2	E0.09	0.007	67.0	112	*714
KINGFP-08	60.7	51.3	3.94	37.3	327	0.6	0.23	14.1	0.11	0.004	53.5	98.5	530
KINGFP-09	24.6	21.0	2.44	19.6	182	0.3	0.04	7.62	0.12	E0.001	46.1	11.1	228
KINGFP-10	21.5	20.4	2.16	20.7	E201	E0.6	0.05	5.92	0.12	—	41.1	13.1	211
KINGFP-11	95.0	80.3	4.58	53.0	548	1.0	0.34	43.5	E0.09	0.003	53.3	124	*762
KINGFP-12	189	98.7	6.54	120	566	0.6	0.68	124	E0.07	0.007	61.0	*360	*1,420
KINGFP-13	80.5	38.2	8.98	32.3	297	0.5	0.19	83.7	E0.09	0.003	71.8	27.0	*520
KINGFP-14	34.7	19.5	9.42	92.9	322	0.5	0.09	88.4	0.18	0.043	63.1	14.4	482
KINGFP-15	34.6	21.9	11.1	88.8	302	0.4	0.14	79.1	E0.09	0.042	71.0	9.22	468
HWY99T-01	28.1	11.3	3.84	21.4	nc	nc	0.03	5.88	0.12	E0.001	50.9	7.98	214

¹ Bicarbonate and carbonate concentrations were calculated from the laboratory alkalinity and pH values (table 4) using the advanced speciation method (<http://or.water.usgs.gov/alk/methods.html>) with $pK_1 = 6.35$, $pK_2 = 10.33$, and $pK_w = 14$.

² Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists.

³ The recommended SMCL-CA thresholds for chloride, sulfate, and TDS are listed with the upper SMCL-CA thresholds in parentheses.

Table 10. Trace elements detected in samples collected for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.

[The five-digit parameter code below the constituent name is used by the U.S. Geological Survey to uniquely identify a specific constituent or property. Samples from the 44 intermediate and slow wells were analyzed. KING, Kings study area; KWH, Kaweah study area; TULE, Tule study area; TLR, Tulare Lake study area; KINGFP, Kings study area flow-path well; HWY99T, Highway 99 transect well; AL, U.S. Environmental Protection Agency action level; HAL, U.S. Environmental Protection Agency Lifetime Health Advisory Level; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; NL, California Department of Public Health notification level; SMCL-CA, California Department of Public Health secondary maximum contaminant level; E, estimated value; LRL, laboratory reporting level; na, not available; V, analyte detected in sample and an associated blank, thus data are not included in ground-water quality assessment; µg/L, microgram per liter; —, not detected; *, value is above threshold value]

GAMA identification no.	Aluminum, filtered (µg/L) (01106)	Antimony, filtered (µg/L) (01095)	Arsenic, filtered (µg/L) (01000)	Barium, filtered (µg/L) (01005)	Beryllium, filtered (µg/L) (01010)	Boron, filtered (µg/L) (01020)	Cadmium, filtered (µg/L) (01025)	Chromium, filtered (µg/L) (01030)
LRL	2	0.2	0.2	0.2	0.06	8	0.04	0.8
Threshold type ¹	MCL-US	MCL-US	MCL-US	MCL-CA	MCL-US	NL	MCL-US	MCL-CA
Threshold (µg/L)	1,000	6	10	1,000	4	1,000	5	50
Grid wells								
KING-04	3.3	E0.17	6.8	17	E0.04	68	—	1.6
KING-09	4.6	—	1.4	8	—	E 7	—	1.3
KING-10	E1.1	—	1.7	28	—	14	—	1.2
KING-11	—	—	1.8	58	—	27	E0.03	1.3
KING-12	E1.0	—	1.7	100	—	28	E0.02	1.2
KING-13	—	—	2.6	55	—	32	—	2.0
KING-15	—	—	1.6	59	—	28	0.04	5.7
KING-16	—	—	2.3	24	—	16	—	4.2
KING-17	—	—	2.5	46	—	23	0.04	6.6
KING-20	E0.9	—	1.4	5	—	E 8	—	0.36
KING-25	E1.0	—	2.2	87	—	36	—	3.6
KING-30	E1.3	—	2.8	27	—	15	—	1.1
KING-38	2.2	—	3.0	53	—	21	—	4.7
KWH-03	E1.0	—	0.64	41	—	19	—	0.96
KWH-06	—	—	2.0	244	—	98	—	4.7
KWH-11	34.1	—	3.4	5	—	767	—	0.04
KWH-12	2.3	—	0.66	25	—	19	—	1.8
KWH-14	E1.2	E0.17	0.62	55	—	22	—	0.65
TULE-01	5.1	E0.11	4.5	11	—	33	—	9.5
TULE-03	7.5	—	*14.9	16	—	90	—	0.41
TULE-07	31.3	E0.18	7.6	9	E0.03	72	—	0.56
TULE-08	121	E0.16	*19.8	6	E0.04	52	—	2.2
TULE-17	E0.8	E0.12	*12.8	30	—	33	—	9.6
TLR-02	263	—	5.1	10	—	597	E0.02	0.35
TLR-04	29.1	—	5.5	19	—	*1,150	E0.03	E 0.03
TLR-05	46.8	—	12.0	2	—	440	E0.03	0.06
TLR-06	E1.5	—	8.2	22	—	*1,170	0.12	0.09
TLR-08	4.3	—	*27.3	13	—	75	—	0.04

Table 10. Trace elements detected in samples collected for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.—Continued

[The five-digit parameter code below the constituent name is used by the U.S. Geological Survey to uniquely identify a specific constituent or property. Samples from the 44 intermediate and slow wells were analyzed. KING, Kings study area; KWH, Kaweah study area; TULE, Tule study area; TLR, Tulare Lake study area; KINGFP, Kings study area flow-path well; HWY99T, Highway 99 transect well; AL, U.S. Environmental Protection Agency action level; HAL, U.S. Environmental Protection Agency Lifetime Health Advisory Level; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; NL, California Department of Public Health notification level; SMCL-CA, California Department of Public Health secondary maximum contaminant level; E, estimated value; LRL, laboratory reporting level; na, not available; V, analyte detected in sample and an associated blank, thus data are not included in ground-water quality assessment; µg/L, microgram per liter; —, not detected; *, value is above threshold value]

GAMA identification no.	Aluminum, filtered (µg/L) (01106)	Antimony, filtered (µg/L) (01095)	Arsenic, filtered (µg/L) (01000)	Barium, filtered (µg/L) (01005)	Beryllium, filtered (µg/L) (01010)	Boron, filtered (µg/L) (01020)	Cadmium, filtered (µg/L) (01025)	Chromium, filtered (µg/L) (01030)
LRL	2	0.2	0.2	0.2	0.06	8	0.04	0.8
Threshold type¹	MCL-US	MCL-US	MCL-US	MCL-CA	MCL-US	NL	MCL-US	MCL-CA
Threshold (µg/L)	1,000	6	10	1,000	4	1,000	5	50
Understanding wells								
KINGFP-01	E0.9	—	1.4	114	—	12	—	2.8
KINGFP-02	E1.4	—	2.1	49	—	11	—	3.0
KINGFP-03	1.8	—	2.5	42	—	17	E0.02	5.2
KINGFP-04	—	—	1.7	88	—	20	—	3.4
KINGFP-05	E0.9	—	0.90	95	—	15	E0.03	1.9
KINGFP-06	E1.0	—	2.1	54	—	17	—	2.8
KINGFP-07	—	—	0.66	220	—	37	—	1.1
KINGFP-08	1.8	—	0.94	148	—	17	—	0.77
KINGFP-09	E0.8	—	1.5	47	—	12	—	2.9
KINGFP-10	E1.3	—	1.9	64	—	13	—	1.3
KINGFP-11	E0.8	—	1.2	95	—	15	—	3.2
KINGFP-12	—	—	0.73	48	—	28	E0.03	3.6
KINGFP-13	—	—	2.2	114	—	22	—	5.7
KINGFP-14	—	—	*18.8	86	—	129	0.24	0.13
KINGFP-15	—	—	*15.4	64	—	176	—	0.25
HWY99T-01	—	—	1.6	45	—	18	—	3.9

Table 10. Trace elements detected in samples collected for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.—Continued

[The five-digit parameter code below the constituent name is used by the U.S. Geological Survey to uniquely identify a specific constituent or property. Samples from the 44 intermediate and slow wells were analyzed. KING, Kings study area; KWH, Kaweah study area; TULE, Tule study area; TLR, Tulare Lake study area; KINGFP, Kings study area flow-path well; HWY99T, Highway 99 transect well; AL, U.S. Environmental Protection Agency action level; HAL, U.S. Environmental Protection Agency Lifetime Health Advisory Level; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; NL, California Department of Public Health notification level; SMCL-CA, California Department of Public Health secondary maximum contaminant level; E, estimated value; LRL, laboratory reporting level; na, not available; V, analyte detected in sample and an associated blank, thus data are not included in ground-water quality assessment; µg/L, microgram per liter; —, not detected; *, value is above threshold value]

GAMA identification no.	Cobalt, filtered (µg/L) (01035)	Copper, filtered (µg/L) (01040)	Iron, filtered (µg/L) (01046)	Lead, filtered (µg/L) (01049)	Lithium, filtered (µg/L) (01130)	Manganese, filtered (µg/L) (01056)	Molybdenum, filtered (µg/L) (01060)	Nickel, filtered (µg/L) (01065)
LRL	0.014	0.4	6	0.08	0.6	0.2	0.4	0.06
Threshold type¹	na	AL	SMCL-CA	AL	na	SMCL-CA	HAL	MCL-CA
Threshold (µg/L)	na	1,300	300	15	na	50	40	100
Grid wells								
KING-04	—	E0.2	E 5	0.20	19.7	0.3	5.6	0.08
KING-09	—	—	—	0.22	0.9	E0.1	0.7	—
KING-10	—	0.7	—	1.42	2.3	—	1.3	E0.03
KING-11	—	0.7	7	E0.07	E0.4	1.5	3.5	—
KING-12	—	1.5	—	0.36	0.9	E0.1	1.8	0.13
KING-13	—	3.0	—	0.89	1.2	E0.1	2.0	E0.03
KING-15	—	0.78	—	0.17	5.1	—	1.7	0.10
KING-16	—	4.5	—	0.78	1.4	E0.2	2.2	0.06
KING-17	—	1.9	—	0.91	1.4	E0.1	1.6	—
KING-20	—	1.0	E 3	1.22	—	—	0.4	E0.05
KING-25	—	2.2	E 4	0.36	2.5	0.3	3.1	0.10
KING-30	—	0.88	—	0.32	1.0	—	1.9	E0.04
KING-38	E0.020	1.9	—	0.54	1.0	E0.2	2.7	0.32
KWH-03	—	0.72	E 4	0.19	E0.4	—	0.8	0.06
KWH-06	0.060	4.7	22	2.95	9.4	0.5	2.2	0.20
KWH-11	—	E0.2	15	E0.04	0.9	2.3	5.6	0.14
KWH-12	E0.023	1.6	9	1.68	0.9	0.4	1.4	0.27
KWH-14	0.046	1.2	—	0.55	1.3	—	E0.2	0.48
TULE-01	—	E0.3	E 6	0.20	2.4	—	5.3	0.15
TULE-03	E0.020	—	E 4	0.24	2.0	E0.1	1.3	0.28
TULE-07	—	E0.3	—	0.12	2.3	—	E0.3	0.12
TULE-08	E0.023	1.1	6	0.12	0.9	0.2	3.5	E0.04
TULE-17	E0.030	0.7	—	0.26	3.6	—	5.7	0.30
TLR-02	0.051	0.6	20	0.23	1.0	2.3	10.9	0.14
TLR-04	—	—	E 6	—	2.0	16.9	8.0	—
TLR-05	—	0.8	26	0.12	1.3	1.0	7.4	0.08
TLR-06	0.061	1.7	181	—	7.2	*66.2	38.2	0.40
TLR-08	E0.024	0.8	E 5	0.19	3.0	6.6	3.9	0.27

Table 10. Trace elements detected in samples collected for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.—Continued

[The five-digit parameter code below the constituent name is used by the U.S. Geological Survey to uniquely identify a specific constituent or property. Samples from the 44 intermediate and slow wells were analyzed. KING, Kings study area; KWH, Kaweah study area; TULE, Tule study area; TLR, Tulare Lake study area; KINGFP, Kings study area flow-path well; HWY99T, Highway 99 transect well; AL, U.S. Environmental Protection Agency action level; HAL, U.S. Environmental Protection Agency Lifetime Health Advisory Level; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; NL, California Department of Public Health notification level; SMCL-CA, California Department of Public Health secondary maximum contaminant level; E, estimated value; LRL, laboratory reporting level; na, not available; V, analyte detected in sample and an associated blank, thus data are not included in ground-water quality assessment; µg/L, microgram per liter; —, not detected; *, value is above threshold value]

GAMA identification no.	Cobalt, filtered (µg/L) (01035)	Copper, filtered (µg/L) (01040)	Iron, filtered (µg/L) (01046)	Lead, filtered (µg/L) (01049)	Lithium, filtered (µg/L) (01130)	Manganese, filtered (µg/L) (01056)	Molybdenum, filtered (µg/L) (01060)	Nickel, filtered (µg/L) (01065)
LRL	0.014	0.4	6	0.08	0.6	0.2	0.4	0.06
Threshold type¹	na	AL	SMCL-CA	AL	na	SMCL-CA	HAL	MCL-CA
Threshold (µg/L)	na	1,300	300	15	na	50	40	100
Understanding wells								
KINGFP-01	E0.02	4.9	9	0.34	1.7	—	0.8	0.21
KINGFP-02	—	0.7	E 5	0.32	0.9	—	2.4	—
KINGFP-03	—	0.8	E 6	0.13	0.9	—	2.5	E0.04
KINGFP-04	—	1.3	—	0.19	2.3	E0.1	1.5	0.15
KINGFP-05	0.26	0.42	11	—	1.9	0.5	1.0	0.94
KINGFP-06	V0.02	—	E 5	—	0.9	E0.1	1.2	0.40
KINGFP-07	0.10	0.52	—	—	6.5	0.2	E0.2	0.69
KINGFP-08	1.0	—	E 4	—	2.4	28.4	8.4	26.9
KINGFP-09	0.07	—	7	—	E0.5	0.4	2.2	1.7
KINGFP-10	0.07	—	—	—	1.4	—	1.4	0.29
KINGFP-11	0.09	0.95	E 5	—	2.2	0.8	0.9	0.98
KINGFP-12	0.24	V0.54	—	E0.05	3.7	E0.2	0.5	0.74
KINGFP-13	0.18	V0.41	—	—	6.8	—	1.1	V0.65
KINGFP-14	5.8	V0.37	50	E0.06	8.8	* 2,910	3.1	8.9
KINGFP-15	10.2	1.2	168	—	18.4	* 651	4.0	16.7
HWY99T-01	—	0.89	—	0.28	4.7	—	1.3	—

Table 10. Trace elements detected in samples collected for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.—Continued

[The five-digit parameter code below the constituent name is used by the U.S. Geological Survey to uniquely identify a specific constituent or property. Samples from the 44 intermediate and slow wells were analyzed. KING, Kings study area; KWH, Kaweah study area; TULE, Tule study area; TLR, Tulare Lake study area; KINGFP, Kings study area flow-path well; HWY99T, Highway 99 transect well; AL, U.S. Environmental Protection Agency action level; HAL, U.S. Environmental Protection Agency Lifetime Health Advisory Level; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; NL, California Department of Public Health notification level; SMCL-CA, California Department of Public Health secondary maximum contaminant level; E, estimated value; LRL, laboratory reporting level; na, not available; V, analyte detected in sample and an associated blank, thus data are not included in ground-water quality assessment; µg/L, microgram per liter; —, not detected; *, value is above threshold value]

GAMA identification no.	Selenium, filtered (µg/L) (01145)	Strontium, filtered (µg/L) (01080)	Thallium, filtered (µg/L) (01057)	Tungsten, filtered (µg/L) (01155)	Uranium, filtered (µg/L) (22703)	Vanadium, filtered (µg/L) (01085)	Zinc, filtered (µg/L) (01090)
LRL	0.4	0.4	0.04	0.5	0.04	0.1	0.04
Threshold type ¹	MCL-US	HAL	MCL-US	na	MCL-US	NL	HAL
Threshold (µg/L)	50	4,000	2	na	30	50	2,000
Grid wells							
KING-04	0.66	143	—	3.0	21.6	22.1	0.87
KING-09	0.11	181	—	0.33	1.79	8.0	E0.44
KING-10	0.12	261	—	0.67	10.7	11.7	1.9
KING-11	0.22	262	—	E0.04	0.69	46.6	1.4
KING-12	0.09	354	—	0.11	3.89	32.8	4.8
KING-13	0.27	172	—	0.11	0.53	44.4	1.7
KING-15	0.28	193	—	0.30	2.41	17.7	1.3
KING-16	0.14	104	—	0.22	0.54	23.4	0.67
KING-17	0.26	173	—	0.39	1.56	37.1	3.1
KING-20	—	58.9	—	0.23	0.98	4.7	2.6
KING-25	0.33	300	0.05	0.40	6.79	43.6	2.0
KING-30	0.44	192	—	0.34	0.77	48.4	2.2
KING-38	0.30	235	—	0.26	0.95	*60.1	1.5
KWH-03	0.09	329	—	0.08	4.95	6.1	0.94
KWH-06	0.94	540	—	E0.04	1.31	19.1	7.2
KWH-11	—	20.9	—	30.9	0.07	0.55	1.1
KWH-12	0.30	275	—	0.10	3.53	7.5	3.2
KWH-14	0.09	410	E0.03	0.08	5.30	6.5	1.2
TULE-01	0.41	125	—	1.0	0.69	39.3	—
TULE-03	E0.04	142	—	1.3	8.74	1.4	1.5
TULE-07	0.10	91.0	—	0.67	3.37	35.6	—
TULE-08	0.08	18.4	—	1.7	0.16	8.8	—
TULE-17	0.45	254	—	3.4	2.04	37.2	2.7
TLR-02	—	21.1	—	99.2	0.05	0.38	—
TLR-04	—	46.1	—	21.7	—	—	—
TLR-05	—	14.2	—	61.0	0.23	0.22	0.7
TLR-06	—	111	—	25.6	0.41	0.29	13.5
TLR-08	0.28	80.9	—	6.1	*38.3	2.2	—

Table 10. Trace elements detected in samples collected for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.—Continued

[The five-digit parameter code below the constituent name is used by the U.S. Geological Survey to uniquely identify a specific constituent or property. Samples from the 44 intermediate and slow wells were analyzed. KING, Kings study area; KWH, Kaweah study area; TULE, Tule study area; TLR, Tulare Lake study area; KINGFP, Kings study area flow-path well; HWY99T, Highway 99 transect well; AL, U.S. Environmental Protection Agency action level; HAL, U.S. Environmental Protection Agency Lifetime Health Advisory Level; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; NL, California Department of Public Health notification level; SMCL-CA, California Department of Public Health secondary maximum contaminant level; E, estimated value; LRL, laboratory reporting level; na, not available; V, analyte detected in sample and an associated blank, thus data are not included in ground-water quality assessment; µg/L, microgram per liter; —, not detected; *, value is above threshold value]

GAMA identification no.	Selenium, filtered (µg/L) (01145)	Strontium, filtered (µg/L) (01080)	Thallium, filtered (µg/L) (01057)	Tungsten, filtered (µg/L) (01155)	Uranium, filtered (µg/L) (22703)	Vanadium, filtered (µg/L) (01085)	Zinc, filtered (µg/L) (01090)
LRL	0.4	0.4	0.04	0.5	0.04	0.1	0.04
Threshold type¹	MCL-US	HAL	MCL-US	na	MCL-US	NL	HAL
Threshold (µg/L)	50	4,000	2	na	30	50	2,000
Understanding wells							
KINGFP-01	0.18	516	—	0.21	17.1	26.4	2.2
KINGFP-02	0.21	196	—	0.23	0.92	39.4	E0.52
KINGFP-03	0.23	200	—	0.35	0.94	43.1	0.89
KINGFP-04	0.11	277	—	0.33	7.17	23.7	1.2
KINGFP-05	—	432	—	0.70	14.8	17.4	1.3
KINGFP-06	0.21	176	—	0.25	0.97	35.1	—
KINGFP-07	—	866	—	E0.04	19.2	12.3	—
KINGFP-08	E0.05	402	—	0.71	10.9	16.1	E0.30
KINGFP-09	0.10	148	—	0.26	0.93	28.4	—
KINGFP-10	0.18	144	—	0.80	0.66	26.3	—
KINGFP-11	—	558	—	0.96	22.2	24.3	E0.57
KINGFP-12	0.09	1140	—	0.12	*78.3	17.3	1.0
KINGFP-13	0.18	560	—	0.35	18.8	20.7	E0.52
KINGFP-14	—	366	—	7.6	1.23	4.0	—
KINGFP-15	—	312	—	10.8	0.93	15.8	E0.40
HWY99T-01	0.11	236	—	0.20	6.11	10.4	—

¹ Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists.

Table 11. Species of inorganic arsenic and iron in samples collected for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.

[The five-digit parameter code below the constituent name is used by the U.S. Geological Survey to uniquely identify a specific constituent or property. Analyses made by the U.S. Geological Survey Trace Metals Laboratory. Samples from the 44 intermediate and slow wells were analyzed. KING, Kings study area; KWH, Kaweah study area; TULE, Tule study area; TLR, Tulare Lake study area; KINGFP, Kings study area flow-path well; HWY99T, Highway 99 transect well; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; MCL-CA, California Department of Public Health maximum contaminant level; MDL, method detection limit; SMCL-CA, California Department of Public Health secondary maximum contaminant level; na, not available; µg/L, micrograms per liter; *, value is above threshold; — not detected]

GAMA identification no.	Arsenic, filtered (µg/L) (99033)	Arsenic (III), filtered (µg/L) (99034)	Iron, filtered (µg/L) (01046)	Iron (II), filtered (µg/L) (01047)
MDL	0.5	1	2	2
Threshold type¹	MCL-US	na	SMCL-CA	na
Threshold (µg/L)	10	na	300	na
Grid wells				
KING-04	3.2	—	—	—
KING-09	0.85	—	—	—
KING-10	1.0	—	—	—
KING-11	1.1	—	6	—
KING-12	0.97	—	—	—
KING-13	1.5	—	—	—
KING-15	1.0	—	—	—
KING-16	1.4	—	—	—
KING-17	1.5	—	—	—
KING-20	0.9	—	—	—
KING-25	1.4	—	—	—
KING-30	1.9	—	—	—
KING-38	2.5	—	3	3
KWH-03	—	—	—	—
KWH-06	0.84	—	14	8
KWH-11	2.6	2.4	5	3
KWH-12	—	—	2	—
KWH-14	—	—	—	—
TULE-01	1.7	—	—	—
TULE-03	7.7	5.8	2	—
TULE-07	6.7	—	—	—
TULE-08	18	5.0	6	5
TULE-17	8.8	—	—	—
TLR-02	3.8	5.4	11	10
TLR-04	4.7	4.7	6	6
TLR-05	17	14	10	10
TLR-06	8.2	5.4	119	104
TLR-08	*24	14	3	2

Table 11. Species of inorganic arsenic and iron in samples collected for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.—Continued

[The five-digit parameter code below the constituent name is used by the U.S. Geological Survey to uniquely identify a specific constituent or property. Analyses made by the U.S. Geological Survey Trace Metals Laboratory. Samples from the 44 intermediate and slow wells were analyzed. KING, Kings study area; KWH, Kaweah study area; TULE, Tule study area; TLR, Tulare Lake study area; KINGFP, Kings study area flow-path well; HWY99T, Highway 99 transect well; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; MCL-CA, California Department of Public Health maximum contaminant level; MDL, method detection limit; SMCL-CA, California Department of Public Health secondary maximum contaminant level; na, not available; µg/L, micrograms per liter; *, value is above threshold; — not detected]

GAMA identification no.	Arsenic, filtered (µg/L) (99033)	Arsenic (III), filtered (µg/L) (99034)	Iron, filtered (µg/L) (01046)	Iron (II), filtered (µg/L) (01047)
MDL	0.5	1	2	2
Threshold type¹	MCL-US	na	SMCL-CA	na
Threshold (µg/L)	10	na	300	na
Understanding wells				
KINGFP-01	0.81	—	4	3
KINGFP-02	1.2	—	—	—
KINGFP-03	1.5	—	—	—
KINGFP-04	0.9	—	—	—
KINGFP-05	—	—	—	—
KINGFP-06	1.3	—	—	—
KINGFP-07	—	—	6	4
KINGFP-08	1.1	—	4	4
KINGFP-09	—	—	3	—
KINGFP-10	1.3	—	—	—
KINGFP-11	0.71	—	3	2
KINGFP-12	—	—	2	—
KINGFP-13	1.1	—	—	—
KINGFP-14	7.2	1.5	75	72
KINGFP-15	8.5	1.6	17	15
HWY99T-01	1.2	—	—	—

¹Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists.

Table 12. Results for analyses of radioactive constituents, tritium, and carbon isotopes in samples collected for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.

[The five-digit parameter code below the constituent name is used by the U.S. Geological Survey to uniquely identify a specific constituent or property. Samples from the 24 slow wells were analyzed for alpha and beta radioactivity, radon, radium, and carbon isotopes. Samples from the 44 intermediate and slow wells were analyzed for tritium and uranium isotopes. Stable isotope ratios are reported in the standard delta notation (δ), the ratio of a heavier isotope to more common lighter isotope of that element, relative to a standard reference material. KING, Kings study area; KWH, Kaweah study area; TULE, Tule study area; TLR, Tulare Lake study area; KINGFP, Kings study area flow-path well; HWY99T, Highway 99 transect well; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; MCL-CA, California Department of Public Health maximum contaminant level; E, estimated value; na, not available; nc, sample not collected; pCi/L, picocuries per liter; <, less than; *, value is above threshold]

GAMA identification no.	Alpha radioactivity, 72-hour count (pCi/L) (62636)	Alpha radioactivity, 30-day count (pCi/L) (62639)	Beta radioactivity, 72-hour count (pCi/L) (62642)	Beta radioactivity, 30-day count (pCi/L) (62645)	Radium-226 (pCi/L) (09511)	Radium-228 (pCi/L) (81366)
Threshold type¹	MCL-US	MCL-US	MCL-CA	MCL-CA	MCL-US²	MCL-US²
Threshold	15	15	50	50	5	5
Grid wells						
KING-04	*21	*22	8.7	18	0.067	E0.23
KING-06	nc	nc	nc	nc	nc	nc
KING-09	nc	nc	nc	nc	nc	nc
KING-10	nc	nc	nc	nc	nc	nc
KING-11	nc	nc	nc	nc	nc	nc
KING-12	nc	nc	nc	nc	nc	nc
KING-13	nc	nc	nc	nc	nc	nc
KING-15	nc	nc	nc	nc	nc	nc
KING-16	nc	nc	nc	nc	nc	nc
KING-17	E2.0	E1.2	4.3	4.0	0.071	E0.36
KING-20	E1.5	E0.7	E2.2	E1.8	E0.026	<0.47
KING-25	nc	nc	nc	nc	nc	nc
KING-30	nc	nc	nc	nc	nc	nc
KING-38	nc	nc	nc	nc	nc	nc
KWH-03	nc	nc	nc	nc	nc	nc
KWH-06	nc	nc	nc	nc	nc	nc
KWH-11	nc	nc	nc	nc	nc	nc
KWH-12	E2.3	3.4	<2.3	2.7	E0.016	<0.46
KWH-14	4.5	2.9	E1.2	E2.8	E0.017	E0.36
TULE-01	E1.4	<0.84	E1.9	<1.3	E0.019	<0.46
TULE-03	nc	nc	nc	nc	nc	nc
TULE-07	nc	nc	nc	nc	nc	nc
TULE-08	E0.8	<1.9	<2.4	<2.2	<0.033	<0.54
TULE-17	nc	nc	nc	nc	nc	nc
TLR-02	nc	nc	nc	nc	nc	nc
TLR-04	E2.0	<1.9	E5.1	E1.3	E0.026	<0.51
TLR-05	E4.8	E4.9	E4.8	E4.4	E0.051	<0.48
TLR-06	nc	nc	nc	nc	nc	nc
TLR-08	nc	nc	nc	nc	nc	nc

Table 12. Results for analyses of radioactive constituents, tritium, and carbon isotopes in samples collected for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.—Continued

[The five-digit parameter code below the constituent name is used by the U.S. Geological Survey to uniquely identify a specific constituent or property. Samples from the 24 slow wells were analyzed for alpha and beta radioactivity, radon, radium, and carbon isotopes. Samples from the 44 intermediate and slow wells were analyzed for tritium and uranium isotopes. Stable isotope ratios are reported in the standard delta notation (δ), the ratio of a heavier isotope to more common lighter isotope of that element, relative to a standard reference material. KING, Kings study area; KWH, Kaweah study area; TULE, Tule study area; TLR, Tulare Lake study area; KINGFP, Kings study area flow-path well; HWY99T, Highway 99 transect well; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; MCL-CA, California Department of Public Health maximum contaminant level; E, estimated value; na, not available; nc, sample not collected; pCi/L, picocuries per liter; <, less than; *, value is above threshold]

GAMA identification no.	Alpha radioactivity, 72-hour count (pCi/L) (62636)	Alpha radioactivity, 30-day count (pCi/L) (62639)	Beta radioactivity, 72-hour count (pCi/L) (62642)	Beta radioactivity, 30-day count (pCi/L) (62645)	Radium-226 (pCi/L) (09511)	Radium-228 (pCi/L) (81366)
Threshold type ¹	MCL-US	MCL-US	MCL-CA	MCL-CA	MCL-US ²	MCL-US ²
Threshold	15	15	50	50	5	5
Understanding wells						
KINGFP-01	*24	14.0	5.9	12.0	0.110	E0.75
KINGFP-02	E2.7	E1.1	E1.6	E1.6	E0.078	<0.52
KINGFP-03	E2.9	E1.7	E2.2	E1.9	E0.082	E0.30
KINGFP-04	7.3	5.1	6.2	7.7	E0.041	E0.40
KINGFP-05	12.0	12.1	5.2	10.3	E0.048	E0.47
KINGFP-06	E3.3	E1.7	E2.2	E4.0	E0.074	<0.37
KINGFP-07	14	6.9	8.0	16.8	0.106	0.59
KINGFP-08	10.7	11.3	5.7	11.4	0.130	0.71
KINGFP-09	E1.6	E0.6	E2.1	E3.0	E0.021	<0.46
KINGFP-10	E1.6	<2.0	E3.3	E2.7	E0.058	<0.46
KINGFP-11	*21	11.2	5.8	13.8	0.063	<0.47
KINGFP-12	*52	*38	11.9	42	E0.035	0.77
KINGFP-13	*20	12.1	11.0	15.8	0.125	E0.47
KINGFP-14	7.4	E2.5	11.9	10.6	0.174	0.99
KINGFP-15	E3.4	<2.3	14.3	13.3	0.071	0.63
HWY99T-01	nc	nc	nc	nc	nc	nc

Table 12. Results for analyses of radioactive constituents, tritium, and carbon isotopes in samples collected for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.—Continued

[The five-digit parameter code below the constituent name is used by the U.S. Geological Survey to uniquely identify a specific constituent or property. Samples from the 24 slow wells were analyzed for alpha and beta radioactivity, radon, radium, and carbon isotopes. Samples from the 44 intermediate and slow wells were analyzed for tritium and uranium isotopes. Stable isotope ratios are reported in the standard delta notation (δ), the ratio of a heavier isotope to more common lighter isotope of that element, relative to a standard reference material. KING, Kings study area; KWH, Kaweah study area; TULE, Tule study area; TLR, Tulare Lake study area; KINGFP, Kings study area flow-path well; HWY99T, Highway 99 transect well; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; MCL-CA, California Department of Public Health maximum contaminant level; E, estimated value; na, not available; nc, sample not collected; pCi/L, picocuries per liter; <, less than; *, value is above threshold]

GAMA identification no.	Radon-222 (pCi/L) (82303)	Tritium (pCi/L) (07000)	Carbon-14 (percent modern) (49933)	$\delta^{13}\text{C}$ (per mil) (82081)	Uranium-234, filtered, (pCi/L) (22610)	Uranium-235, filtered, (pCi/L) (22620)	Uranium-238, filtered, (pCi/L) (22603)
Threshold type ¹	Proposed MCL-US	MCL-CA	na	na	MCL-CA ⁴	MCL-CA ⁴	MCL-CA ⁴
Threshold	300 (4,000) ³	20,000	na	na	20	20	20
Grid wells							
KING-04	*490	7.7	60.5	−15.2	9.4	0.28	6.6
KING-06	nc	<1	nc	nc	nc	nc	nc
KING-09	nc	5.1	nc	nc	0.72	<0.056	0.64
KING-10	nc	16.0	nc	nc	4.65	0.14	3.65
KING-11	nc	<1	nc	nc	0.53	<0.043	0.20
KING-12	nc	10.8	nc	nc	1.92	E0.08	1.22
KING-13	nc	<1	nc	nc	0.45	<0.041	0.21
KING-15	nc	1.0	nc	nc	1.35	E0.034	0.78
KING-16	nc	4.2	nc	nc	0.30	<0.041	0.19
KING-17	*490	<1	66.9	−14.1	0.88	E0.021	0.55
KING-20	*2,720	14.4	116	−15.0	0.44	<0.048	0.30
KING-25	nc	2.6	nc	nc	3.10	0.12	2.28
KING-30	nc	<1	nc	nc	0.58	E0.021	0.29
KING-38	nc	<0.6	nc	nc	0.56	E0.023	0.36
KWH-03	nc	24.0	nc	nc	2.06	E0.10	1.65
KWH-06	nc	2.9	nc	nc	0.81	E0.036	0.35
KWH-11	nc	1.9	nc	nc	E0.036	<0.029	E0.026
KWH-12	*590	16.0	85.7	−15.3	1.47	0.097	1.28
KWH-14	*810	13.8	105	−15.3	2.14	0.11	1.84
TULE-01	*480	5.4	42.5	−12.6	0.18	E0.018	0.16
TULE-03	nc	20.2	nc	nc	3.44	0.15	2.87
TULE-07	nc	11.8	nc	nc	1.38	E0.042	1.03
TULE-08	*620	<0.6	42.1	−13.2	E0.02	<0.003	E0.039
TULE-17	nc	1.6	nc	nc	na	E0.020	na
TLR-02	nc	<1	nc	nc	<0.034	<0.033	E0.022
TLR-04	*720	<0.6	0.73	−20.9	E0.020	<0.029	<0.024
TLR-05	*1,200	1.0	7.7	−16.7	0.12	E0.020	0.18
TLR-06	nc	<0.6	nc	nc	0.35	<0.031	0.14
TLR-08	nc	<0.6	nc	nc	7.5	0.38	6.1

Table 12. Results for analyses of radioactive constituents, tritium, and carbon isotopes in samples collected for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.—Continued

[The five-digit parameter code below the constituent name is used by the U.S. Geological Survey to uniquely identify a specific constituent or property. Samples from the 24 slow wells were analyzed for alpha and beta radioactivity, radon, radium, and carbon isotopes. Samples from the 44 intermediate and slow wells were analyzed for tritium and uranium isotopes. Stable isotope ratios are reported in the standard delta notation (δ), the ratio of a heavier isotope to more common lighter isotope of that element, relative to a standard reference material. KING, Kings study area; KWH, Kaweah study area; TULE, Tule study area; TLR, Tulare Lake study area; KINGFP, Kings study area flow-path well; HWY99T, Highway 99 transect well; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; MCL-CA, California Department of Public Health maximum contaminant level; E, estimated value; na, not available; nc, sample not collected; pCi/L, picocuries per liter; <, less than; *, value is above threshold]

GAMA identification no.	Radon-222 (pCi/L) (82303)	Tritium (pCi/L) (07000)	Carbon-14 (percent modern) (49933)	$\delta^{13}\text{C}$ (per mil) (82081)	Uranium-234, filtered, (pCi/L) (22610)	Uranium-235, filtered, (pCi/L) (22620)	Uranium-238, filtered, (pCi/L) (22603)
Threshold type ¹	Proposed MCL-US	MCL-CA	na	na	MCL-CA ⁴	MCL-CA ⁴	MCL-CA ⁴
Threshold	300 (4,000) ³	20,000	na	na	20	20	20
Understanding wells							
KINGFP-01	*580	5.1	105	-14.4	9.3	0.29	6.3
KINGFP-02	*600	<1	47.9	-16.5	0.66	E0.025	0.28
KINGFP-03	*620	<1	42.8	-16.3	0.47	E0.018	0.28
KINGFP-04	*720	7.7	102	-13.5	3.66	E0.08	2.13
KINGFP-05	*300	10.2	nc	nc	7.0	0.20	4.82
KINGFP-06	*560	<1	79.2	-13.1	0.58	E0.016	0.32
KINGFP-07	*300	12.5	114	-16.1	7.3	0.35	6.6
KINGFP-08	*520	21.8	118	-15.9	4.91	0.16	3.68
KINGFP-09	*910	<1	93.0	-14.1	0.69	E0.053	0.24
KINGFP-10	*350	1.9	nc	nc	0.46	<0.03	0.22
KINGFP-11	*400	7.0	121	-14.1	10.7	0.41	6.9
KINGFP-12	*550	8.3	124	-13.3	*27.4	1.13	*22.9
KINGFP-13	*680	5.4	91.6	-10.9	8.1	0.33	5.6
KINGFP-14	*1340	11.5	97.3	-7.8	0.54	E0.032	0.39
KINGFP-15	*400	12.8	96.7	-10.6	0.43	E0.017	0.28
HWY99T-01	nc	16.3	nc	nc	2.74	E0.12	2.1

¹ Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists.

² Combined radium-226 plus radium-228.

³ The MCL-US threshold for radium is the sum of radium-226 and radium-228.

⁴ Combined uranium-234, uranium-235 and uranium-238.

Table 13. Results for analyses of microbial indicators in samples collected for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.

[The five-digit parameter code below the constituent name is used by the U.S. Geological Survey to uniquely identify a specific constituent or property. Samples were analyzed for the thirteen slow wells that were not monitoring wells. KING, Kings study area; KWH, Kaweah study area; TULE, Tule study area; TLR, Tulare Lake study area; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; TT, treatment technique - a required process intended to reduce the level of a contaminant in drinking water; M, presence verified but not quantified; nc, not collected; >, greater than; —, not detected; *, value is above threshold value]

GAMA identification no.	Coliphage F-specific (99335)	Coliphage somatic (99332)	<i>Escherichia coli</i> (colonies/100 mL) (90901)	Total coliforms (colonies/100 mL) (90900)
Threshold type	TT	TT	TT	MCL-US
Threshold	99.9 percent killed/inactive	99.9 percent killed/inactive	No fecal coliforms are allowed	No more than 5 percent of samples positive for total coliform in a month
TULE-01	—	—	—	*44
TLR-04	—	M	—	—
TLR-05	—	—	—	* >80

Table 14. Hydrogen and oxygen isotopes of water, and oxygen and nitrogen isotopes of nitrate in samples collected for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.

[The five-digit parameter code below the constituent name is used by the U.S. Geological Survey to uniquely identify a specific constituent or property. Samples from 98 wells were analyzed for stable isotopes of water; samples from 34 of the intermediate and slow wells were analyzed for stable isotopes of nitrate, nitrate was not detected in the remaining 10 intermediate and slow wells. Stable isotope ratios are reported in the standard delta notation (δ), the ratio of a heavier isotope to more common lighter isotope of that element, relative to a standard reference material. KING, Kings study area; KWH, Kaweah study area; TULE, Tule study area; TLR, Tulare Lake study area; KINGFP, Kings study area flow-path well; HWY99T, Highway 99 transect well; na, not available; nc, not collected]

GAMA identification no.	$\delta^2\text{H}$ in water (per mil) (82082)	$\delta^{18}\text{O}$ in water (per mil) (82085)	$\delta^{15}\text{N}$ in nitrate (per mil) (82690)	$\delta^{18}\text{O}$ in nitrate (per mil) (63041)
Threshold type	na	na	na	na
Threshold	na	na	na	na
Grid wells				
KING-01	-71.6	-9.67	nc	nc
KING-02	-82.9	-11.20	nc	nc
KING-04	-72.2	-9.41	6.95	3.06
KING-05	-81.1	-11.01	nc	nc
KING-06	-102	-13.76	nc	nc
KING-07	-94.2	-13.03	nc	nc
KING-08	-100	-13.75	nc	nc
KING-09	-101	-13.59	nc	nc
KING-10	-96.7	-13.29	6.97	-1.22
KING-11	-61.3	-8.14	4.25	0.56
KING-12	-77.1	-10.27	5.51	1.77
KING-13	-61.7	-8.10	3.58	0.36
KING-14	-68.4	-9.23	nc	nc
KING-15	-64.5	-8.56	4.71	0.42
KING-16	-73.2	-9.95	3.73	-0.56
KING-17	-61.2	-7.71	3.96	1.40
KING-18	-99.0	-13.54	nc	nc
KING-19	-66.1	-8.60	nc	nc
KING-20	-98.8	-13.39	5.38	3.85
KING-21	-96.5	-13.12	nc	nc
KING-22	-91.0	-11.97	nc	nc
KING-23	-84.2	-11.30	nc	nc
KING-24	-85.2	-11.50	nc	nc
KING-25	-62.4	-8.28	3.49	-0.55
KING-26	-70.9	-9.47	nc	nc
KING-27	-64.6	-8.78	nc	nc
KING-28	-95.5	-13.30	nc	nc
KING-29	-68.2	-8.70	nc	nc
KING-30	-75.0	-10.22	2.98	0.59
KING-31	-85.5	-11.06	nc	nc
KING-32	-101	-13.86	nc	nc
KING-33	-64.8	-8.57	nc	nc
KING-34	-86.4	-11.50	nc	nc
KING-35	-72.7	-9.80	nc	nc

Table 14. Hydrogen and oxygen isotopes of water, and oxygen and nitrogen isotopes of nitrate in samples collected for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.—Continued

[The five-digit parameter code below the constituent name is used by the U.S. Geological Survey to uniquely identify a specific constituent or property. Samples from 98 wells were analyzed for stable isotopes of water; samples from 34 of the intermediate and slow wells were analyzed for stable isotopes of nitrate, nitrate was not detected in the remaining 10 intermediate and slow wells. Stable isotope ratios are reported in the standard delta notation (δ), the ratio of a heavier isotope to more common lighter isotope of that element, relative to a standard reference material. KING, Kings study area; KWH, Kaweah study area; TULE, Tule study area; TLR, Tulare Lake study area; KINGFP, Kings study area flow-path well; HWY99T, Highway 99 transect well; na, not available; nc, not collected]

GAMA identification no.	$\delta^2\text{H}$ in water (per mil) (82082)	$\delta^{18}\text{O}$ in water (per mil) (82085)	$\delta^{15}\text{N}$ in nitrate (per mil) (82690)	$\delta^{18}\text{O}$ in nitrate (per mil) (63041)
Threshold type	na	na	na	na
Threshold	na	na	na	na
KING-36	-66.1	-9.04	nc	nc
KING-37	-94.0	-12.93	nc	nc
KING-38	-62.0	-8.10	3.42	1.04
KING-39	-68.3	-9.01	nc	nc
KWH-01	-86.7	-12.09	nc	nc
KWH-02	-87.0	-11.92	nc	nc
KWH-03	-90.4	-12.56	4.27	-2.54
KWH-04	-80.2	-11.10	nc	nc
KWH-05	-72.2	-9.51	nc	nc
KWH-06	-61.0	-7.84	nc	nc
KWH-07	-63.9	-8.33	nc	nc
KWH-08	-75.9	-9.68	nc	nc
KWH-09	-86.6	-12.09	nc	nc
KWH-10	-64.0	-7.84	nc	nc
KWH-11	-83.1	-11.43	nc	nc
KWH-12	-87.2	-12.21	4.91	-3.21
KWH-13	-80.8	-11.00	nc	nc
KWH-14	-83.3	-11.48	6.77	-0.90
KWH-15	-90.5	-12.13	nc	nc
KWH-16	-86.7	-12.01	nc	nc
KWH-17	-86.1	-11.70	nc	nc
KWH-18	-83.7	-11.63	nc	nc
TULE-01	-68.6	-9.50	3.84	-0.44
TULE-02	-80.9	-11.29	nc	nc
TULE-03	-82.8	-11.50	5.78	-0.62
TULE-04	-65.9	-8.44	nc	nc
TULE-05	-68.4	-8.66	nc	nc
TULE-06	-69.9	-8.93	nc	nc
TULE-07	-79.4	-11.16	4.14	-1.20
TULE-08	-70.0	-9.82	2.70	-1.97
TULE-09	-73.1	-10.28	nc	nc
TULE-10	-72.9	-10.30	nc	nc
TULE-11	-78.1	-10.78	nc	nc
TULE-12	-67.4	-9.32	nc	nc
TULE-13	-83.9	-11.62	nc	nc
TULE-14	-68.6	-9.93	nc	nc
TULE-15	-78.5	-10.88	nc	nc

Table 14. Hydrogen and oxygen isotopes of water, and oxygen and nitrogen isotopes of nitrate in samples collected for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.—Continued

[The five-digit parameter code below the constituent name is used by the U.S. Geological Survey to uniquely identify a specific constituent or property. Samples from 98 wells were analyzed for stable isotopes of water; samples from 34 of the intermediate and slow wells were analyzed for stable isotopes of nitrate, nitrate was not detected in the remaining 10 intermediate and slow wells. Stable isotope ratios are reported in the standard delta notation (δ), the ratio of a heavier isotope to more common lighter isotope of that element, relative to a standard reference material. KING, Kings study area; KWH, Kaweah study area; TULE, Tule study area; TLR, Tulare Lake study area; KINGFP, Kings study area flow-path well; HWY99T, Highway 99 transect well; na, not available; nc, not collected]

GAMA identification no.	$\delta^2\text{H}$ in water (per mil) (82082)	$\delta^{18}\text{O}$ in water (per mil) (82085)	$\delta^{15}\text{N}$ in nitrate (per mil) (82690)	$\delta^{18}\text{O}$ in nitrate (per mil) (63041)
Threshold type	na	na	na	na
Threshold	na	na	na	na
TULE-16	-94.9	-12.74	nc	nc
TULE-17	-65.2	-9.07	6.04	-0.06
TLR-01	-84.5	-11.32	nc	nc
TLR-02	-79.8	-10.72	nc	nc
TLR-03	-80.5	-11.06	nc	nc
TLR-04	-80.2	-10.57	nc	nc
TLR-05	-85.3	-11.69	nc	nc
TLR-06	-65.4	-8.93	nc	nc
TLR-07	-66.1	-9.02	nc	nc
TLR-08	-88.2	-11.78	nc	nc
TLR-09	-73.0	-10.11	nc	nc
Understanding wells				
KINGFP-01	-63.3	-8.12	5.40	3.84
KINGFP-02	-60.1	-7.62	3.97	1.00
KINGFP-03	-59.0	-7.56	3.94	1.29
KINGFP-04	-71.8	-9.43	5.18	-1.07
KINGFP-05	-80.3	-10.59	6.14	2.35
KINGFP-06	-61.6	-7.89	3.49	1.37
KINGFP-07	-81.4	-10.98	6.24	3.22
KINGFP-08	-86.3	-11.71	5.37	2.31
KINGFP-09	-73.7	-9.78	4.69	-0.02
KINGFP-10	-71.0	-9.33	4.24	0.75
KINGFP-11	-64.7	-8.53	5.80	1.08
KINGFP-12	-62.4	-7.86	6.19	3.03
KINGFP-13	-72.2	-9.36	6.84	0.87
KINGFP-14	-68.7	-8.43	nc	nc
KINGFP-15	-70.9	-8.98	nc	nc
HWY99T-01	-77.7	-10.55	3.64	0.79

Table 15. Results for analyses of noble gases and tritium in samples collected for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.

[The five-digit parameter code below the constituent name is used by the U.S. Geological Survey to uniquely identify a specific constituent or property. Samples were analyzed for 99 wells by the Lawrence-Livermore National Laboratory. KING, Kings study area; KWH, Kaweah study area; TULE, Tule study area; TLR, Tulare Lake study area; KINGFP, Kings study area flow-path well; HWY99T, Highway 99 transect well; MCL-CA, California Department of Public Health maximum contaminant level; cm³ STP g⁻¹ H₂O, cubic centimeters at standard temperature and pressure per gram of water; na, not available; nc, sample not collected; nr, not reported, analysis failed laboratory quality-assurance tests; pCi/L, picocuries per liter; <, less than]

GAMA identification no.	Collection date (mm/dd/ yyyy)	Tritium (pCi/L) (07000)	Tritium measurement uncertainty (+/-) (pCi/L) (07001)	Dissolved gas analysis date (mm/dd/yyyy)	Helium-3/ Helium-4 (atom ratio) (61040)	Helium-4 (85561)	Neon (61046)	Argon (85563)	Krypton (85565)	Xenon (85567)
					(cm ³ STP g ⁻¹ H ₂ O)					
					x 10 ⁻⁶	x 10 ⁻⁷	x 10 ⁻⁷	x 10 ⁻⁴	x 10 ⁻⁸	x 10 ⁻⁸
Threshold type ¹	na	MCL-CA	na	na	na	na	na	na	na	na
Threshold	na	20,000	na	na	na	na	na	na	na	na
Grid wells										
KING-01	10/17/2005	<1	0.2	11/23/2005	0.30	3.60	2.58	3.93	8.58	1.17
KING-02	10/17/2005	3.9	0.4	11/23/2005	0.87	7.46	2.31	8.30	7.10	1.07
KING-03	10/17/2005	15.7	0.9	11/23/2005	1.26	5.05	2.39	4.03	7.88	1.10
KING-04	10/17/2005	7.9	0.7	11/23/2005	0.78	3.43	2.36	3.57	7.68	1.00
KING-05	10/18/2005	<1	0.2	11/30/2005	0.34	5.93	2.42	8.52	7.75	1.15
KING-06	10/18/2005	<1	0.2	11/23/2005	0.71	3.26	2.15	3.63	8.12	1.11
KING-07	10/18/2005	23.5	1.1	11/30/2005	1.88	0.82	3.46	4.23	8.84	1.14
KING-08	10/19/2005	1.0	0.3	11/30/2005	1.66	0.60	2.43	3.66	8.14	1.09
KING-09	10/19/2005	5.7	0.5	11/30/2005	2.00	0.64	2.58	3.84	8.37	1.11
KING-10	10/19/2005	17.1	0.9	11/30/2005	2.39	0.66	2.71	3.84	8.30	1.11
KING-11	10/20/2005	1.3	0.4	11/30/2005	0.64	2.28	2.47	3.48	7.39	0.94
KING-12	10/20/2005	11.8	0.7	12/01/2005	1.91	0.74	2.88	3.84	8.17	1.02
KING-13	10/20/2005	<1	0.3	12/01/2005	0.65	1.58	2.24	3.34	7.15	0.95
KING-14	10/24/2005	<1	0.3	12/01/2005	0.73	1.29	2.49	3.72	8.02	1.10
KING-15	10/25/2005	<1	0.4	11/29/2005	1.14	0.77	2.16	3.23	7.17	0.95
KING-16	10/25/2005	<1	0.2	11/29/2005	1.70	0.66	2.59	3.82	8.13	1.07
KING-17	10/26/2005	1.2	0.3	12/06/2005	0.92	0.98	2.12	3.29	7.18	0.94
KING-18	10/26/2005	24.3	1.1	12/02/2005	3.57	0.65	2.60	3.90	8.60	1.16
KING-19	10/27/2005	3.5	0.4	12/02/2005	1.18	0.92	2.58	3.55	7.38	0.98
KING-20	10/27/2005	17.5	0.9	12/02/2005	2.09	0.55	2.40	3.69	8.21	1.13
KING-21	10/27/2005	5.3	0.4	12/06/2005	1.28	1.47	1.93	4.78	7.56	1.04
KING-22	11/01/2005	14.4	0.8	12/03/2005	1.79	0.73	3.03	3.85	7.85	1.00
KING-23	11/01/2005	25.7	1.2	12/05/2005	2.03	0.97	3.73	4.26	8.58	1.06
KING-24	11/01/2005	20.9	1.0	12/05/2005	2.34	0.55	2.29	3.51	7.70	1.02
KING-25	11/02/2005	2.6	0.4	12/05/2005	0.64	2.71	2.45	3.46	7.31	0.96
KING-26	11/02/2005	1.0	0.4	12/08/2005	0.20	11.64	2.68	8.80	7.98	1.12
KING-27	11/02/2005	<1	0.3	12/07/2005	0.90	1.01	2.28	3.52	7.72	0.97
KING-28	11/03/2005	11.7	0.6	12/07/2005	1.35	0.55	2.37	3.64	8.04	0.98
KING-29	11/03/2005	13.9	0.7	12/07/2005	0.88	2.57	2.35	3.45	7.08	0.98
KING-30	11/03/2005	<1	0.3	12/07/2005	0.46	2.40	2.15	3.29	7.33	0.98
KING-31	11/14/2005	1.0	0.3	12/07/2005	0.68	1.43	30.31	3.66	8.06	1.10
KING-32	11/14/2005	<1	0.5	12/07/2005	1.28	0.58	2.18	3.58	8.11	1.13
KING-33	11/17/2005	2.8	0.4	02/16/2006	0.76	64.06	2.36	3.47	7.40	1.02
KING-34	11/28/2005	nr	nr	02/18/2006	2.17	0.86	3.11	3.47	7.39	0.99
KING-35	12/01/2005	nr	nr	03/21/2006	1.53	0.62	2.32	3.42	7.57	0.97

Table 15. Results for analyses of noble gases and tritium in samples collected for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.—Continued

[The five-digit parameter code below the constituent name is used by the U.S. Geological Survey to uniquely identify a specific constituent or property. Samples were analyzed for 99 wells by the Lawrence-Livermore National Laboratory. KING, Kings study area; KWH, Kaweah study area; TULE, Tule study area; TLR, Tulare Lake study area; KINGFP, Kings study area flow-path well; HWY99T, Highway 99 transect well; MCL-CA, California Department of Public Health maximum contaminant level; cm³ STP g⁻¹ H₂O, cubic centimeters at standard temperature and pressure per gram of water; na, not available; nc, sample not collected; nr, not reported, analysis failed laboratory quality-assurance tests; pCi/L, picocuries per liter; <, less than]

GAMA identification no.	Collection date (mm/dd/ yyyy)	Tritium (pCi/L) (07000)	Tritium measurement uncertainty (+/-) (pCi/L) (07001)	Dissolved gas analysis date (mm/dd/yyyy)	Helium-3/ Helium-4 (atom ratio) (61040)	Helium-4 (85561)	Neon (61046)	Argon (85563)	Krypton (85565)	Xenon (85567)
					(cm ³ STP g ⁻¹ H ₂ O)					
					x 10 ⁻⁶	x 10 ⁻⁷	x 10 ⁻⁷	x 10 ⁻⁴	x 10 ⁻⁸	x 10 ⁻⁸
Threshold type ¹	na	MCL-CA	na	na	na	na	na	na	na	na
Threshold	na	20,000	na	na	na	na	na	na	na	na
KING-36	12/08/2005	<1	0.3	03/23/2006	1.14	0.76	3.97	4.46	8.32	1.14
KING-37	12/14/2005	17.2	1.0	03/24/2006	1.88	0.67	2.77	3.74	7.82	1.01
KING-38	12/15/2005	<1	0.3	03/28/2006	0.62	2.87	1.99	3.10	7.03	0.91
KING-39	12/15/2005	<1	0.3	03/29/2006	0.41	3.68	2.57	8.57	7.43	1.10
KWH-01	10/31/2005	22.3	1.0	12/03/2005	2.81	0.74	2.69	3.87	8.17	1.10
KWH-02	10/31/2005	14.5	0.8	12/02/2005	1.68	0.67	2.76	3.85	8.20	1.09
KWH-03	10/31/2005	30.0	1.3	12/02/2005	3.23	0.74	3.10	4.12	8.66	1.11
KWH-04	11/15/2005	14.0	0.8	12/08/2005	1.34	2.46	2.39	3.62	7.85	1.06
KWH-05	11/15/2005	24.1	1.2	12/08/2005	1.61	0.61	2.43	3.39	7.36	0.95
KWH-06	11/15/2005	<1	1.7	12/08/2005	1.21	5.43	5.05	5.13	9.33	1.16
KWH-07	11/16/2005	15.9	0.9	12/09/2005	0.74	10.38	2.32	3.42	7.41	0.97
KWH-08	11/16/2005	9.7	0.7	12/09/2005	1.12	7.87	2.16	3.31	7.21	0.97
KWH-09	11/16/2005	29.9	1.4	02/16/2006	2.27	0.92	3.77	4.57	8.70	1.15
KWH-10	11/17/2005	10.3	0.7	02/17/2006	1.26	8.36	14.04	7.79	14.51	1.48
KWH-11	11/17/2005	nr	nr	02/17/2006	1.02	7.98	2.52	3.82	8.30	1.13
KWH-12	11/28/2005	nr	nr	02/18/2006	2.86	0.68	3.59	4.06	8.52	1.13
KWH-13	11/30/2005	nr	nr	03/20/2006	1.53	0.73	3.09	4.17	8.42	1.08
KWH-14	11/30/2005	nr	nr	03/21/2006	2.15	0.66	2.77	3.92	8.25	1.14
KWH-15	12/01/2005	nr	nr	03/21/2006	1.59	1.09	2.48	3.68	8.03	1.08
KWH-16	12/07/2005	28.5	1.3	03/22/2006	2.07	1.02	4.17	4.77	9.16	1.16
KWH-17	12/13/2005	35.1	1.6	03/23/2006	2.27	0.97	4.02	4.78	9.10	1.12
KWH-18	12/13/2005	18.8	0.9	03/24/2006	1.78	0.83	3.07	4.15	8.47	1.08
TULE-01	11/29/2005	nr	nr	03/20/2006	1.42	0.68	2.52	3.66	7.81	1.05
TULE-02	11/30/2005	nr	nr	03/20/2006	2.16	0.97	3.92	4.61	9.11	1.14
TULE-03	11/30/2005	nr	nr	03/21/2006	3.02	0.74	3.02	3.99	8.25	1.12
TULE-04	12/05/2005	<1	0.3	03/28/2006	0.97	1.35	3.78	4.35	8.43	1.06
TULE-05	12/05/2005	1.9	0.4	03/22/2006	0.74	38.57	1.76	4.46	7.06	0.99
TULE-06	12/05/2005	<1	0.3	03/28/2006	0.46	17.25	2.45	4.27	8.05	1.12
TULE-07	12/06/2005	13.6	0.8	03/22/2006	2.09	0.74	2.78	3.82	8.28	1.09
TULE-08	12/07/2005	<1	0.4	03/22/2006	1.02	0.76	2.38	3.51	7.62	1.05
TULE-09	12/07/2005	11.6	0.8	03/22/2006	2.43	0.59	2.51	3.66	7.94	1.11
TULE-10	12/07/2005	6.0	0.5	03/22/2006	1.56	0.74	3.66	4.21	8.29	1.07
TULE-11	12/08/2005	2.0	1.9	03/23/2006	0.46	1.96	3.81	8.56	7.88	1.22
TULE-12	12/08/2005	<1	0.3	03/23/2006	0.60	1.26	3.08	4.59	7.94	1.06
TULE-13	12/13/2005	13.9	0.8	03/23/2006	1.84	0.58	2.52	3.63	7.94	1.04
TULE-14	12/13/2005	6.6	0.5	03/23/2006	1.67	0.79	3.24	4.13	8.37	1.09
TULE-15	12/14/2005	<1	0.2	nc	nc	nc	nc	nc	nc	nc

Table 15. Results for analyses of noble gases and tritium in samples collected for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.—Continued

[The five-digit parameter code below the constituent name is used by the U.S. Geological Survey to uniquely identify a specific constituent or property. Samples were analyzed for 99 wells by the Lawrence-Livermore National Laboratory. KING, Kings study area; KWH, Kaweah study area; TULE, Tule study area; TLR, Tulare Lake study area; KINGFP, Kings study area flow-path well; HWY99T, Highway 99 transect well; MCL-CA, California Department of Public Health maximum contaminant level; cm³ STP g⁻¹ H₂O, cubic centimeters at standard temperature and pressure per gram of water; na, not available; nc, sample not collected; nr, not reported, analysis failed laboratory quality-assurance tests; pCi/L, picocuries per liter; <, less than]

GAMA identification no.	Collection date (mm/dd/ yyyy)	Tritium (pCi/L) (07000)	Tritium measurement uncertainty (+/-) (pCi/L) (07001)	Dissolved gas analysis date (mm/dd/yyyy)	Helium-3/ Helium-4 (atom ratio) (61040)	Helium-4 (85561)	Neon (61046)	Argon (85563)	Krypton (85565)	Xenon (85567)
					(cm ³ STP g ⁻¹ H ₂ O)					
					x 10 ⁻⁶	x 10 ⁻⁷	x 10 ⁻⁷	x 10 ⁻⁴	x 10 ⁻⁸	x 10 ⁻⁸
Threshold type ¹	na	MCL-CA	na	na	na	na	na	na	na	na
Threshold	na	20,000	na	na	na	na	na	na	na	na
TULE-16	12/14/2005	8.1	0.6	03/23/2006	1.96	0.73	2.91	3.55	7.42	0.97
TULE-17	02/28/2006	2.8	0.3	05/15/2002	1.34	0.81	3.09	4.16	8.51	1.08
TLR-01	11/28/2005	nr	nr	air contaminated	na	na	na	na	na	na
TLR-02	11/29/2005	nr	nr	03/20/2006	0.51	3.85	2.27	3.88	8.22	1.16
TLR-03	11/29/2005	nr	nr	03/20/2006	0.87	17.69	2.27	3.70	8.22	1.14
TLR-04	12/01/2005	nr	nr	03/21/2006	1.13	52.97	2.31	3.99	8.01	1.15
TLR-05	12/05/2005	1.7	0.3	03/21/2006	0.99	9.07	2.22	3.88	8.27	1.18
TLR-06	12/06/2005	<1	0.3	03/22/2006	0.29	2.81	2.79	4.04	8.90	1.19
TLR-07	12/06/2005	<1	0.3	03/22/2006	0.83	1.23	3.16	4.59	9.13	1.29
TLR-08	12/12/2005	2.2	0.4	03/28/2006	1.23	3.13	2.26	3.64	7.99	1.08
TLR-09	12/14/2005	<1	0.3	03/28/2006	0.11	2.04	0.71	8.64	7.14	0.77
Understanding wells										
KINGFP-01	10/18/2005	4.8	0.4	11/30/2005	1.16	0.83	2.23	3.29	7.22	0.95
KINGFP-02	10/19/2005	2.2	0.4	11/30/2005	0.58	3.57	2.08	3.13	6.70	0.90
KINGFP-03	10/20/2005	<1	0.3	11/30/2005	0.63	2.67	2.06	3.13	6.93	0.90
KINGFP-04	10/25/2005	5.0	1.2	11/29/2005	1.61	0.62	2.33	3.48	7.53	0.99
KINGFP-05	10/31/2005	nr	nr	12/02/2005	1.86	0.74	2.56	3.61	7.65	1.00
KINGFP-06	11/01/2005	<1	0.3	12/05/2005	0.64	2.44	2.12	3.22	6.96	0.94
KINGFP-07	11/01/2005	13.2	0.7	12/06/2005	1.45	0.55	2.44	3.70	7.84	0.98
KINGFP-08	11/02/2005	23.1	1.1	12/06/2005	2.39	0.55	2.39	3.59	7.58	0.95
KINGFP-09	11/02/2005	1.8	0.3	12/06/2005	1.05	1.29	3.25	4.02	8.21	1.00
KINGFP-10	11/03/2005	nr	nr	12/08/2005	0.71	2.60	2.49	3.53	7.58	1.00
KINGFP-11	11/14/2005	6.5	0.6	12/07/2005	1.33	0.71	2.52	3.59	7.32	0.99
KINGFP-12	11/14/2005	8.5	0.6	12/08/2005	1.46	0.51	2.20	3.31	7.11	0.95
KINGFP-13	11/15/2005	4.6	0.5	12/08/2005	1.62	0.59	2.42	3.50	7.51	0.99
KINGFP-14	11/16/2005	12.5	0.8	12/09/2005	1.33	0.59	2.50	3.61	7.13	0.89
KINGFP-15	11/16/2005	12.3	0.7	02/16/2006	1.31	0.66	2.68	3.91	8.12	1.07
HWY99T-01	10/25/2005	15.1	0.9	12/01/2005	1.80	0.80	2.35	3.57	7.97	1.07

¹ Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists.

Appendix

This appendix includes discussions of the methods used for sample collection, data analysis, data reporting, and quality assurance. The methods used for the GAMA Priority Basin Assessment project were selected to obtain representative samples of the ground water from each well, and to minimize the potential for contamination of the samples or bias in the data. Procedures used to collect and assess quality-control data and the results of these assessments also are discussed.

Sample Collection

Ground-water samples were collected using standard and modified USGS protocols from the USGS NAWQA program (Koterba and others, 1995) and the USGS National Field Manual (Lane and others, 2003; Wilde, 2004; Wilde and others, 2004; 2006b), and protocols described by Weiss (1968); Shelton and others (2001); and Wright and others (2005). These sampling protocols ensure that a representative sample of ground water was collected at each site, and that the samples were collected and handled in a way that minimized the potential for airborne contamination of samples and cross-contamination between samples collected at wells.

Prior to sampling, each well was pumped continuously to purge at least three casing-volumes of water from the well (Wilde and others, 2006b). Wells were sampled using Teflon tubing with brass and stainless-steel fittings attached to a sampling point on the well discharge pipe as close to the well as possible (Lane and others, 2003). The sampling point was located upstream of any well-head treatment system, such as chlorination, or of any water storage tanks. If a chlorinating system was attached to the well, the chlorinator was shut off at least 24 hours prior to purging and sampling the well to purge the system of extraneous chlorine. For the *fast* and *intermediate* schedules, samples were collected at the well head using a foot-long length of Teflon tubing attached to a spigot on the discharge pipe. For the *slow* schedule, the samples were collected inside an enclosed flow-through chamber located inside a mobile laboratory and connected to the well head by a 25–50 ft length of the Teflon tubing (Lane and others, 2003). All fittings and lengths of tubing were cleaned between samples (Wilde, 2004).

For the field measurements (water-quality indicators), ground water was pumped through a flow-through chamber fitted with a multi-probe meter that simultaneously measures dissolved oxygen (DO), water temperature, pH, and specific conductance (SC). Field measurements were made in accordance with protocols in the USGS National Field Manual (Radtke and others, 2005; Wilde and Radtke, 2005; Lewis, 2006; Wilde, 2006; Wilde and others, 2006a). All sensors on the multi-probe meter were calibrated daily. Measured DO, temperature, pH, and SC values were recorded at 3- to 5-minute intervals, for at least 30 minutes, and when these values remained stable for at least five readings, samples for

laboratory analyses were collected. Aliquots were collected to measure turbidity with a portable turbidity meter. Samples for alkalinity titrations were collected by filtering ground water into 500-mL polyethylene bottles. Alkalinities for *slow* samples were titrated in the field. Alkalinities for *intermediate* samples were titrated at NWQL.

Field measurements and instrument calibrations were recorded by hand on field record sheets and electronically in personal-computer-field-form-GAMA (PCFF-GAMA), a software package designed by the USGS with support from the GAMA program. Analytical service requests and chain of custody documentation also were managed by PCFF-GAMA. Information from PCFF-GAMA was uploaded directly into NWIS at the end of every week of sample collection.

For analyses requiring filtered water, ground water was diverted through a 0.45-micrometer (μm) vented capsule filter, disk filter, or a baked glass-fiber filter, depending on the collection protocol for the analyte (Wilde and others, 2004; 2006b). Polyethylene sample bottles were pre-rinsed three times using de-ionized water (DIW) in the office laboratory. DIW from the third rinse was left in the bottles until sample collection. Prior to sample collection, the DIW was discarded and the polyethylene bottles were rinsed once with native water. Samples requiring acidification were acidified to a pH of 2 or less with the appropriate acids using ampoules of certified, traceable concentrated acids obtained from the USGS National Water Quality Laboratory (NWQL).

Temperature-sensitive samples were stored on ice prior to shipping to various laboratories. Volatile organic compounds (VOC), pesticides, compounds of special interest, dissolved organic carbon (DOC), radium isotopes, gross alpha and beta radioactivity, and radon-222 samples were shipped daily. The non-temperature-sensitive samples for tritium, noble gases, chromium speciation, and the stable isotopes were shipped monthly.

Detailed sampling protocols for individual analyses and groups of analytes are described in Koterba and others (1995) and the USGS National Field Manual (Wilde and others, 2004; 2006b), and in the references for analytical methods in [table A1](#); only brief descriptions are given here. Samples for VOCs, and gasoline additives ([tables 3A–C](#)), and 1,2,3-trichloropropane (1,2,3-TCP) ([table 3F](#)) were collected in 40-mL baked amber glass sample vials that were purged with three vial volumes of sample water before bottom-filling to eliminate atmospheric contamination. Six normal (6 N) hydrochloric acid (HCl) was added as a preservative to the VOC samples, but not to the gasoline additive samples, nor to the 1,2,3-TCP samples. Pesticides, polar pesticides, and pesticide degradation products ([tables 3D and E](#)), and NDMA ([table 3F](#)) samples were collected in 1-L baked amber glass bottles. Pesticide samples were filtered with a glass-fiber filter, whereas the NDMA samples were filtered at the Montgomery Watson-Harza Laboratory prior to analysis. Perchlorate ([table 3F](#)) samples were collected in 125-mL polyethylene bottles.

Ground-water samples for major and minor ions, and trace element analyses (table 3H) each required filling one 250-mL polyethylene bottle with raw (unfiltered) ground water, and one 500-mL and one 250-mL polyethylene bottles with filtered ground water (Wilde and others, 2004). Filtration was done using a 0.45- μ m Whatman capsule filter. Each 250-mL filtered sample then was preserved with 7.5 N nitric acid. Mercury (table 3H) samples were collected by filtering ground water into 250-mL glass bottles and preserving each with 6 N HCl. Arsenic and iron speciation (table 3I) samples were each filtered into 250-mL polyethylene bottles that were covered with tape to prevent light exposure, and preserved with 6 N HCl. Nutrient (table 3G) samples were filtered into 125-mL brown polyethylene bottles. Radium isotopes and gross alpha and beta radiation (table 3J) samples were filtered through a 0.45- μ m Whatman capsule filter into 1-L polyethylene bottles and then each were acidified with 7.5 N nitric acid. Each carbon isotope (table 3J) sample was filtered before bottom-filling two 500-mL glass bottles that first were overfilled with three bottle volumes of ground water. These samples had no headspace and were sealed with a conical cap to avoid atmospheric contamination. Tritium (table 3J) samples were collected by bottom-filling 1-L polyethylene bottles with unfiltered ground water, after first overfilling the bottles with three volumes of water (Wilde and others, 2004). Samples for the isotopic composition of oxygen and hydrogen in water (table 3J) were collected in 60-mL clear glass bottles filled with unfiltered water, sealed with conical caps, and secured with electrical tape to prevent leakage and evaporation.

DOC, radon-222, chromium, noble gases, and microbial constituents were collected from the hose bib at the well head, regardless of the sampling schedule (fast, intermediate, or slow). DOC was not collected at monitoring wells. Submersible sampling pumps and tubing used to collect samples from monitoring wells could not be used for DOC sample collection because the equipment was cleaned with methanol after sampling each well and residual methanol from cleaning has been shown to bias DOC samples. Each ground-water sample for DOC was collected using a 50-mL syringe and 0.45- μ m disk filter to filter the water into 125-mL baked glass bottles and then preserved with 4.5 N sulfuric acid (Wilde and others, 2004). For the collection of radon-222 (table 3J), a stainless-steel and Teflon valve assembly was attached to the hose bib at the well head (Wilde and others, 2004). The valve was closed partially to create back pressure, and a 10-mL sample was taken through a Teflon septum on the valve assembly using a glass syringe affixed with a stainless-steel needle. The sample then was injected into a 25-mL vial partially filled with scintillation mixture (mineral oil) and shaken. The vial then was placed in a cardboard tube to shield it from light during shipping.

Chromium speciation (table 3I) samples were collected using a 10-mL syringe with an attached 0.45- μ m disk filter (Ball and McCleskey, 2003a, b). After the syringe was rinsed thoroughly and filled with ground water, 4 mL were forced

through the disk filter and the next 2 mL of the ground water were filtered slowly into a small centrifuge vial for analysis of total chromium. Hexavalent chromium, Cr (VI), then was collected by attaching a small cation-exchange column to the disk filter on the syringe, and after conditioning the column with 2 mL of sample water, 2 mL were collected in a second centrifuge vial. Both vials were preserved with 10 μ L of 7.5 N nitric acid.

Noble gases (table 3K) were collected in 3/8-in. copper tubes using reinforced nylon tubing connected to the hose bib at the wellhead (Weiss, 1968). Ground water was flushed through the tubing to dislodge any bubbles before flow was restricted with a back pressure valve. Clamps on either side of the copper tube then were tightened, trapping a sample of ground water for analyses of noble gases.

Microbial constituents (table 3L) also were collected at the well head, following protocols described in Bushon (2003) and Myers (2004). Prior to the collection of samples, the sampling port was sterilized using isopropyl alcohol, and ground water was run through the sampling port for at least 3 minutes to remove any traces of the sterilizing agent. Two sterilized 500-mL bottles then were filled with ground water for coliform analyses (total and *Escherichia coli* coliform determinations), and one sterilized 3-L carboy was filled for coliphage analyses (F-specific and somatic-coliphage determinations).

Sample Analysis

Nine laboratories performed chemical and microbial analyses for the SESJ study (see table A1). Most of the analyses were performed at the NWQL or by laboratories contracted by the NWQL. The NWQL maintains a rigorous quality-assurance program (Maloney, 2005). Laboratory quality-control samples, including method blanks, continuing calibration verification standards, standard reference samples, reagent spikes, external certified reference materials, and external blind proficiency samples, are analyzed regularly. Method detection limits are tested continuously and laboratory reporting levels updated accordingly. NWQL maintains National Environmental Laboratory Accreditation Program (NELAP) and other certifications (http://nwql.usgs.gov/lab_cert.shtml). In addition, the Branch of Quality Systems within the USGS Office of Water Quality maintains independent oversight of quality assurance at the NWQL and laboratories contracted by the NWQL. The Branch of Quality Systems also runs a National Field Quality Assurance program that includes annual testing of all USGS field personnel for proficiency in making field water-quality measurements (<http://nfqa.cr.usgs.gov/>). Results for analyses made at the NWQL or by laboratories contracted by the NWQL are uploaded directly into NWIS by the NWQL. Laboratory quality-control data also are stored in NWIS.

Alkalinity, total coliforms and *Escherichia coli* (*E. coli*) were measured in the mobile laboratory at the well site. Alkalinity was measured on filtered samples by Gran's titration method (Rounds, 2006). Titration data were entered into PCFF-GAMA, and the concentrations of bicarbonate (HCO_3^-) and carbonate (CO_3^{2-}) were calculated automatically from the titration data using the advanced speciation method. Total coliforms and *E. coli* plates were prepared using sterilized equipment and MI reagents (Myers, 2004). Plates were counted under an ultraviolet light, following a 22–24 hour incubation time.

Data Reporting

Laboratory Reporting Conventions

The USGS NWQL uses the laboratory reporting level (LRL) as a threshold for reporting analytical results. The LRL is set to minimize the reporting of false negatives (not detecting a compound when it actually is present in a sample) to less than 1 percent (Childress and others, 1999). The LRL is set at two-times the long-term method detection level (LT-MDL). The LT-MDL is derived from the standard deviation of at least 24 method detection limit (MDL) determinations made over an extended period of time. The MDL is the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the concentration is greater than zero (at MDL there is less than 1 percent chance of a false positive) (U.S. Environmental Protection Agency, 2002a). The USGS NWQL regularly updates LRL values, and the values listed in this report were in effect during the period analyses were made for ground-water samples from the SESJ study (October 2005 through February 2006).

Detections between the LRL and the LT-MDL are reported as estimated concentrations (designated with an "E" before the value in the tables and text). For information-rich methods, detections below the LT-MDL have high certainty of detection, but the precise concentration is uncertain. Information-rich methods are those that utilize gas chromatography or high-performance liquid chromatography (HPLC) with mass spectrometry detection (used to analyze for VOCs, gasoline additives, and pesticides). For these methods, compounds are identified by the presence of characteristic fragmentation patterns in their mass spectra, in addition to being quantified by measurement of peak areas at their associated chromatographic retention times. E-coded values also may result from detections outside the range of calibration standards, from detections that did not meet all laboratory quality-control criteria, and from samples that were diluted prior to analysis (Childress and others, 1999).

Some compound concentrations in this study are reported using minimum reporting levels (MRLs) or method uncertainties. The MRL is the smallest measurable concentration of a constituent that may be reliably reported by using a given analytical method (Timme, 1995). The method

uncertainty generally indicates the precision of a particular analytical measurement; it gives a range of values wherein the true value will be found.

Detections that may have resulted from sample contamination are reported with a "V" before the values in the tables). The potential for sample contamination was assessed using results from field, source-solution, and laboratory blanks.

The reporting levels for radiochemical constituents (gross-alpha radioactivity, gross-beta radioactivity, radium-226 and -228, and uranium-234, -235, and -238) are based on a sample-specific minimum detectable concentration (SSMDC), a sample-specific critical value, and the combined standard uncertainty (CSU) (U.S. Environmental Protection Agency, 2004; Bennett and others, 2006). A result above the critical value represents a greater-than-95-percent certainty that the result is greater than zero (significantly different from the instrument's background response to a blank sample), and a result above the SSMDC represents a greater-than-95-percent certainty that the result is greater than the critical value. Using these reporting level elements, three unique cases were possible when screening the raw analytical data. If the analytical result was less than the critical value (case 1), the analyte was considered "not detected", and the concentration is reported on [table 13](#) as less than the SSMDC. If the analytical result was greater than the critical value, the ratio of the CSU to the analytical result was calculated as a percent (percent relative CSU). For those samples with percent-relative CSU greater than 20 percent (case 2), concentrations were reported as estimated values (designated by an "E" preceding the value). For those samples with percent-relative CSU less than 20 percent (case 3), concentrations were reported on [table 13](#) with no qualifiers.

Stable isotopic compositions of oxygen, hydrogen, carbon, and nitrogen are reported as relative isotope ratios in units of per mil using the standard delta notation (Coplen and others, 2002):

$$\delta^i E = \left[\frac{R_{\text{sample}}}{R_{\text{reference}}} - 1 \right] \times 1,000$$

Where

- i is the atomic mass of the heavier isotope of the element,
- E is the element (O for oxygen, C for carbon, or H for hydrogen),
- R_{sample} is the ratio of the abundance of the heavier isotope of the element (^{18}O , ^{13}C , or ^2H) to the lighter isotope of the element (^{16}O , ^{12}C , or ^1H) in the sample and,
- $R_{\text{reference}}$ is the ratio of the abundance of the heavier isotope of the element to the lighter isotope of the element in the reference material hydrogen.

The reference material for oxygen and hydrogen is Vienna Standard Mean Ocean Water (VSMOW), which is assigned $\delta^{18}\text{O}$ and $\delta^2\text{H}$ values of 0 per mil (note that $\delta^2\text{H}$ is also written as δD because the common name of the heavier isotope of hydrogen, hydrogen-2, is deuterium). The reference material for carbon is Vienna Pee Dee Belemnite (VPDB), which is assigned a $\delta^{13}\text{C}$ value of 0 per mil, and the reference material for nitrogen is atmospheric nitrogen gas, which is assigned a $\delta^{15}\text{N}$ value of 0 per mil. Positive values of $\delta^i\text{E}$ indicate enrichment of the heavier isotope, and negative values indicate depletion of the heavier isotope, compared to the ratios observed in the standard reference material.

Constituents on Multiple Analytical Schedules

Seventeen constituents targeted in SESJ were determined by more than one analytical schedule or by more than one laboratory (table A2). The preferred methods for these constituents were selected on the basis of the procedure recommended by the NWQL (http://www.nwql.cr.usgs.gov/USGS/Preferred_method_selection_procedure.html). Methods with full approval are preferred over those with provisional approval, and approved methods are favored over research methods. The method with greater accuracy and precision and lower LRLs for the overlapping constituents is preferred. A method may be selected as the preferred method to provide consistency with historical data analyzed by the same method. If a VOC, gasoline additive, or pesticide constituent appears on multiple NWQL analytical schedules, then only the measurement determined by the preferred method is reported. If a constituent was analyzed by more than one laboratory, then both measurements are reported. For example, the VOC, 1,2,3-TCP, was analyzed at the NWQL and at the Montgomery Watson Harza Laboratory (MWH). Since the MWH Laboratory had a lower reporting level (0.005 $\mu\text{g/L}$), it was the preferred method for this constituent for this study, although both are reported. For arsenic and iron concentrations, the standard method used by the NWQL is preferred over the research method used by the USGS Trace Metal Laboratory, although both are reported. The concentrations measured by the Trace Metal Laboratory are used only to calculate ratios

of redox species for each element, $\frac{As(V)}{As(III)}$ for arsenic, and $\frac{Fe(III)}{Fe(II)}$ for iron. For example:

$$\frac{Fe(III)}{Fe(II)} = \frac{Fe(T) - Fe(II)}{Fe(II)}$$

Where

- $Fe(T)$ is the total iron concentration (measured),
- $Fe(II)$ is the concentration of ferrous iron (measured) and,
- $Fe(III)$ is the concentration of ferric iron (calculated).

Tritium results from both the USGS Stable Isotope and Tritium Laboratory and LLNL are reported. The USGS Stable Isotope and Tritium Laboratory method is the preferred method for this study because suspected instrument error at LLNL increased the uncertainty of the tritium values.

Quality Assurance

The quality-assurance procedures used for this study followed the protocols used by the USGS NAWQA program (Koterba and others, 1995) and described in the USGS National Field Manual (U.S. Geological Survey, variously dated). The quality-assurance plan followed by the NWQL, the primary laboratory used to analyze samples for this study, is described in Pirkey and Glodt (1998) and Maloney (2005). Quality-control (QC) samples were collected to evaluate contamination, bias, and variability of the data that may have resulted from sample collection, processing, storage, transportation, and laboratory analysis. QC samples collected in the SESJ study include blanks, field replicates, and matrix and laboratory surrogate spikes.

Blanks

Blank samples (blanks) were collected using water (nitrogen-purged “universal” blank water) certified by the NWQL to contain less than the LRL or MRL of the analytes investigated in the study. Two types of blanks were collected: source-solution and field blanks. Source-solution blanks were collected to verify that the blank water used for the field blanks was free of analytes of interest. Field and source solution blanks were collected at more than 10 percent of the wells sampled to determine if equipment or procedures used in the field or laboratory introduced contamination. Field blanks were analyzed for VOCs, gasoline additives, pesticides, perchlorate, NDMA, 1,2,3-TCP, nutrients, dissolved organic carbon, major and minor ions, trace elements, iron, arsenic, and chromium species, and coliform indicators. Certified blank water was not available for tritium or noble gases; thus, field blanks were not collected for these constituents. Constituents that were detected in field blanks are given in table A3.

Source-solution blanks were collected at the sampling site by pouring blank water directly into sample containers that were then preserved, stored, shipped, and analyzed in the same manner as the ground-water samples. For field blanks, blank water either was pumped or poured through the sampling equipment (fittings and tubing) used to collect ground water, then processed and transported using the same protocols for the ground-water samples.

Contamination in field blanks may originate from several different types of sources, including: contamination of the source-solution water, carry-over from the previous sample, contamination from known sources specific to a field site, and systematic or random contamination from field or laboratory equipment or processes. These different sources of contamination require different strategies for censoring detections in environmental samples based on detections in field blanks.

Detections in source-solution blanks were used to evaluate potential contamination of the source-solution water. If a constituent was detected in a source-solution blank at a concentration equal to or greater than the lowest concentration detected in any field blank collected using the same lot of source-solution water, then the source-solution water was interpreted as the origin of the contamination in the blanks, and detections of that constituent in field blanks collected using the same lot of source-solution water were disregarded.

If a field blank detection could not be attributed to the source solution, then the ground-water samples collected prior to, and following, the blank were evaluated. If the constituent was not detected in the ground-water sample collected prior to the contaminated field blank, then contamination of that field blank resulting from carry-over was ruled out. If non-detections were reported in field blanks or ground-water samples collected after ground-water samples containing high concentrations of the constituent, then carry-over contamination was considered unlikely in the whole dataset. If carry-over contamination in the dataset could not be ruled out, then all detections in ground-water samples and field blanks collected after a ground-water sample containing a high concentration of the constituent were examined for potential censoring.

Contamination from known sources may produce distinctive patterns of detections in field blanks and ground-water samples, particularly for the VOCs. Substances that may be encountered at the field site, such as lubricants (for example, penetrating oil), cements used on PVC-piping, exhaust fumes from pump engines, and the methanol used to clean sample lines, contain recognizable associations of VOC constituents. If a recognizable association of VOC constituents was detected in a field blank, and the field notes indicated that a known source was present and may have affected collection of the field blank, the field blank was not used to censor detections of individual VOCs in ground-water samples. If a recognizable association of VOC constituents was detected in a ground-water sample, and the field notes indicated that a known source was present and may have affected sample collection, the detections in the ground-water sample were examined for potential censoring. However, detection of these co-occurring VOC constituents in ground-water samples does not necessarily indicate contamination during sample collection, because these VOC constituents also may occur together in ground water. The censoring level was defined as the concentration of the constituent in field blanks plus one-half the LRL for that constituent. Detections in ground-water

sample below the censoring level were censored. Censored values are indicated by a 'V' preceding the value in the data tables and they are excluded from the summary statistics.

Replicates

Sequential replicate samples were collected to assess variability that may result from the processing and analyses of inorganic and organic constituents. Relative standard deviation (RSD) of the measured values was used in determining the variability between replicate pairs for each compound ([table A4](#)). The RSD is defined as the standard deviation divided by the mean concentration for each replicate pair of samples, multiplied by 100 percent. If one value in a sample pair was reported as a non-detection and the other value was reported as an estimate below the LRL or MRL, the RSD was set to zero because the values were analytically identical. If one value in a sample pair was reported as a non-detection and the other value was greater than the LRL or MRL, then the non-detection value was set equal to one-quarter of the LRL and the RSD was calculated (Hamlin and others, 2002). Values of RSD less than 20 percent are considered acceptable in this study. High RSD values for a compound may indicate analytical uncertainty at low concentrations, particularly for concentrations within an order of magnitude of LT-MDL or MDL. Sequential replicate samples were collected at 9 percent of the wells sampled.

Matrix Spikes

Addition of a known concentration of a constituent ('spike') to a replicate environmental sample enables the laboratory to determine the effect of the matrix, in this case ground water, on the analytical technique used to measure the constituent. The known compounds added in matrix spikes are the same as those being analyzed in the method. This enables an analysis of matrix interferences on a compound-by-compound basis. Matrix spikes in SESJ were added at the laboratory performing the analysis. Compounds with low recoveries (less than 70 percent of the added compound detected) are of potential concern if environmental concentrations are close to the MCLs; a low recovery could falsely indicate a concentration below the MCL. Conversely, compounds with high recoveries (greater than 130 percent of the added compound detected) are of potential concern if the environmental concentrations exceed MCLs: a high recovery could falsely indicate a concentration above the MCL.

Acceptable ranges for matrix-spike recoveries are based on the acceptable ranges established for laboratory "set" spike recoveries. Laboratory set spikes are aliquots of laboratory blank water to which the same spike solution used for the matrix spikes has been added. One set spike is analyzed with each set of samples. Acceptable ranges for set spike recoveries are 70–130 percent for VOCs and gasoline oxygenates (NWQL schedules 2020 and 4024, Connor and others, 1998;

Zaugg and others, 2002; and Rose and Sandstrom, 2003), 60–120 percent for pesticides (NWQL schedules 2033 and 2060, Furlong and others, 2001; and Sandstrom and others, 2001). Based on these ranges, we defined 70–130 percent as the acceptable range for matrix-spike recoveries for organic compounds in this study.

Matrix spike tests were done for VOCs, gasoline additive compounds, pesticide compounds, NDMA, and 1,2,3-TCP because the analytical methods for these constituents are chromatographic methods that may be susceptible to matrix interferences. Coliphage samples also were spiked to determine if the matrix interferes with growth. Replicate samples for matrix-spike additions were collected at 9 percent of the wells sampled, although not all analyte classes were tested at every well (table A5).

Surrogates

Surrogate compounds are added to environmental samples in the laboratory prior to analysis to evaluate the recovery of similar constituents. Surrogate compounds were added to all of the ground-water and quality-control samples that were analyzed for VOCs, gasoline oxygenates, pesticide and pesticide degradates, NDMA, and 1,2,3-TCP (table A6). Most of the surrogate compounds are deuterated analogs of compounds being analyzed. For example, the surrogate toluene-*d*8 used for the VOC analytical method has the same chemical structure as toluene, except that the eight hydrogen-1 atoms on the molecule have been replaced by deuterium (hydrogen-2). Toluene-*d*8 and toluene behave very similarly in the analytical procedure, but the small mass difference between the two results in slightly different chromatographic retention times, thus, the use of a toluene-*d*8 surrogate does not interfere with the analysis of toluene (Grob, 1995). Only 0.0156 percent of hydrogen atoms are deuterium (Firestone and others, 1996), thus, deuterated compounds like toluene-*d*8 do not occur naturally and are not found in environmental samples. Surrogates are used to identify general problems that may arise during sample analysis that could affect the analysis results for all compounds in that sample. Potential problems include matrix interferences (such as high levels of dissolved organic carbon) that could produce a positive bias, and (or) incomplete laboratory recovery (possibly due to improper maintenance and calibration of analytical equipment) that produces a negative bias. A 70–130 percent recovery of surrogates generally is considered acceptable; values outside this range indicate possible problems with the processing and analysis of samples (table A6) (Connor and others, 1998; Sandstrom and others, 2001).

Quality-Control-Sample Results

Detections in Field Blanks and Source-Solution Blanks

Field and source-solution blanks were collected at more than 10 percent of the sites sampled in SESJ. A summary of detections in field blanks is given in table A3. Nine VOCs were detected in one or more of the eleven field blanks. Two VOCs, toluene and *m*-Xylene plus *p*-xylene, had detections in environmental samples collected prior to or following these field blanks. Two of the toluene detections in environmental samples were near the concentrations found in the blanks and were censored. One environmental sample had a *m*-xylene plus *p*-xylene detection preceded by a blank detection. This environmental sample was censored. The concentrations of three VOCs—acetone, 2-butanone, and tetrahydrofuran—were censored for one sample from an understanding well because of potential contamination resulting from modifications to the wellhead that occurred a few weeks prior to sampling.

One constituent on the pesticide schedules, caffeine, was detected in three field blanks (table A3). Detections of caffeine were observed in environmental samples collected before or after the associated field blanks. Six of the caffeine detections in environmental samples were near the concentrations found in the blanks and were censored.

Five major and minor ions were detected in six field blanks. Four of these constituents were detected in every field blank collected. However, only magnesium was detected in a blank at a concentration high enough to require an environmental sample to be censored.

Fourteen trace elements were detected in field blanks. The NWQL determined that high concentrations of aluminum, barium, chromium, iron, manganese, and strontium in field blanks and source solution blanks collected in late 2005 through early 2006 were the result of systematic contamination of the blank water by leaching from the glass bottles (written communications: USGS NWQL Rapi-Note 06-008, April 2006; USGS NWQL Rapi-Note 06-022, June 2006; James A. Lewis, U.S. Geological Survey, August 2008). All bottles with the same lot numbers as the affected bottles were discarded. No other field blanks were collected for trace element analyses in SESJ, thus, it was not possible to assess potential contamination of the ground-water samples for these three trace elements. The comparison of concentrations of field blank detections with the other trace elements with detections in the environmental samples resulted in the censoring of some of the environmental data for four trace elements (table A3): cobalt, copper, lead, and nickel. Detection of Cr and Cr(VI) in all six field blanks collected for speciation analysis resulted in the censoring of all Cr and Cr(VI) environmental samples. Chromium species were not shown in table 11 because of suspected contamination of samples during the preservation process.

Detections of DOC were observed in both blanks. These concentrations were greater than the concentration detected in two environmental samples, therefore, these two DOC detections were censored. Total nitrogen was detected in one of three blanks, but at a concentration that would have negligible effect on the concentration of environmental samples collected after the blank. Therefore, no total nitrogen analyses were censored.

Variability in Replicate Samples

A summary of the results of replicate analyses for constituents detected in ground-water samples collected in SESJ are presented in [table A4](#). The majority of replicate sample pairs had relative standard deviations (RSDs) of less than 20 percent. Concentrations or activities in the environmental and replicate samples are reported for all replicate analyses with RSD values greater than 20. Two replicate pairs representing two pesticides, nine replicate sample pairs representing eight minor trace elements, six replicate sample pairs for alpha and beta radioactivity, three replicate sample pairs for uranium-234, -235, and -238, and one replicate pair for $\delta^{18}\text{O}$ in nitrate had RSDs greater than 20 percent ([table A4](#)). However, many of the replicate sample pairs with high RSDs had concentrations near the LRL for these constituents; at these low concentrations, small deviations in measured values may account for the large RSDs. No detections were censored as a result of variability in replicate samples.

Matrix-Spike Recoveries

A summary of matrix-spike recoveries for the SESJ study is presented in [table A5](#). Addition of a spike or known concentration of a constituent to an environmental sample enables the analyzing laboratory to determine the effect of the matrix, in this case ground water, on the analytical technique used to measure the constituent. Nine environmental samples were spiked with VOCs, 18 environmental samples with DBCP, and five environmental samples were spiked with NDMA and 1,2,3-TCP (constituents of special interest) to calculate matrix-spike recoveries. Eighty-one of the 88 VOCs and constituents of special interest had spike recoveries within the acceptable range of 70–130 percent. Six VOCs had spike recoveries greater than 130 percent and one VOC had a spike recovery below 70 percent ([table A5](#)); only two of these VOCs were detected in ground-water samples. Trichlorofluoromethane and DBCP were not detected in the environmental samples for which the corresponding spiked samples had recoveries outside of the acceptable range of 70–130 percent. No VOC data were censored on the basis of matrix-spike results.

Seven ground-water samples were spiked with pesticide and pesticide degradate compounds, and three ground-water samples were spiked with polar pesticide and degradate

compounds. Sixty-nine of the 142 spiked compounds had recoveries within the acceptable range. Seventeen pesticide compounds had spike recoveries greater than 130 percent; only two were detected in ground-water samples ([table A5](#)). Both compounds, dinoseb and imazethapyr, were not detected in the unspiked environmental samples corresponding to the spiked samples with high recoveries. Fifty-six pesticide compounds had spike recoveries less than 70 percent ([table A5](#)); 10 of these compounds were detected in ground-water samples, of which two compounds were detected in the environmental samples corresponding to the spiked samples with low recoveries. Low recoveries may indicate that the compound might not have been detected in some samples if it was present at very low concentrations.

Two microbial indicator samples were spiked F-specific and somatic coliphage. Both samples tested positive for F-specific and somatic coliphage, which indicates matrix interference was not a problem.

Surrogate Compound Recoveries

Surrogate compounds were added to environmental samples in the laboratory and analyzed to evaluate the recovery of similar constituents. [Table A6](#) lists each surrogate; the analytical schedule on which it was applied; the number of analyses for ground-water samples, blanks, and sample replicates; and the number of surrogate recoveries below 70 percent and above 130 percent for the ground-water samples, blanks, and replicates. Greater than 92 percent of the ground-water samples, blanks, and replicate samples had recoveries of the surrogates with the acceptable range of 70–130 percent. Diazinon-*d*10 surrogate recoveries were less than 70 percent in about 14 percent of the samples. Diazinon had one detection below the LRL. Surrogate recovery data suggests the detection could be at a higher concentration than reported. 2,4,5-T surrogate recoveries were greater than 130 percent for 40 percent of the samples. This suggests some pesticide compounds on the 2060 schedule may have concentrations higher than reported. No ground-water sample detections were censored as a result of surrogate recovery data.

Table A1. Analytical methods used for the determination of organic, inorganic, and microbial constituents by the U.S. Geological Survey (USGS) National Water Quality Laboratory (NWQL) and additional contract laboratories.

[MI agar, supplemented nutrient agar in which coliforms (total and *Escherichia*) produce distinctly different fluorescence under ultraviolet lighting; DBCP, 1,2-dibromo-3-chloropropane; HPLC, high-pressure liquid chromatography; UV, ultraviolet; VOCs, volatile organic compounds]

Analyte	Method	Laboratory	Citation(s)
Water-quality indicators			
Field parameters	Calibrated field meters and kits	USGS field measurement	Anderson, 2005; Radtke and others, 2005; Lewis, 2006; Rounds, 2006; Wilde, 2006; Wilde and others, 2006a
Organic constituents			
VOCs	Purge and trap capillary gas chromatography-mass spectrometry	NWQL, Schedule 2020	Connor and others, 1998
DBCP	Microextraction and gas chromatography	NWQL, Schedule 1306	U.S. Environmental Protection Agency, 1995
Gasoline oxygenates	Heated purge and trap, gas chromatography-mass spectrometry	NWQL, Schedule 4024	Rose and Sandstrom, 2003
Pesticides and pesticide degradates	Solid-phase extraction and gas chromatography-mass spectrometry	NWQL, Schedules 2033	Zaugg and others, 1995; Lindley and others, 1996; Sandstrom and others, 2001; Madsen and others, 2003
Polar pesticides and pesticide degradates	Solid-phase extraction and gas chromatography-mass spectrometry	NWQL, Schedule 2060	Furlong and others, 2001
Pharmaceuticals	Solid-phase extraction and HPLC/ mass spectrometry	NWQL, Lab code 9003	Kolpin and others, 2002
Constituents of special interest			
Perchlorate	Chromatography and mass spectrometry	Montgomery Watson Harza Laboratory	Hautman and others, 1999
<i>N</i> -Nitrosodimethylamine (NDMA)	Chromatography and mass spectrometry	Montgomery Watson Harza Laboratory	U.S. Environmental Protection Agency, 1996; U.S. Environmental Protection Agency, 1999b
1,2,3-Trichloropropane	Gas chromatography/electron capture detector	Montgomery Watson Harza Laboratory	U.S. Environmental Protection Agency, 1995
Inorganic constituents			
Nutrients	Alkaline persulfate digestion, Kjeldahl digestion	NWQL, Schedule 2755	Fishman, 1993; Patton and Kryskalla, 2003
Dissolved organic carbon	UV-promoted persulfate oxidation and infrared spectrometry	NWQL, Schedule 2612	Brenton and Arnett, 1993
Major and minor ions, and trace elements	Inductively coupled plasma mass spectrometry, graphite furnace atomic absorption, atomic fluorescence, and colorimetry	NWQL, Schedule 1948	Fishman and Friedman, 1989; Faires, 1993; Fishman, 1993; McLain, 1993; American Public Health Association, 1998; Garbarino, 1999; Garbarino and Damrau, 2001; Garbarino and others, 2006
Chromium, arsenic, and iron speciation	Ultraviolet visible (UV-VIS) spectrophotometry and atomic absorbance spectroscopy	USGS Trace Metal Laboratory, Boulder, Colorado	Stookey, 1970; To and others, 1998; Ball and McCleskey, 2003a, 2003b; McCleskey and others, 2003

Table A1. Analytical methods used for the determination of organic, inorganic, and microbial constituents by the U.S. Geological Survey (USGS) National Water Quality Laboratory (NWQL) and additional contract laboratories.—Continued

[MI agar, supplemented nutrient agar in which coliforms (total and *Escherichia*) produce distinctly different fluorescence under ultraviolet lighting; DBCP, 1,2-dibromo-3-chloropropane; HPLC, high-pressure liquid chromatography; UV, ultraviolet; VOCs, volatile organic compounds]

Analyte	Method	Laboratory	Citation(s)
Stable isotopes			
Stable isotopes of water	Gaseous hydrogen and carbon dioxide-water equilibration	USGS Stable Isotope Laboratory, Reston, Virginia, schedule 1142	Epstein and Mayeda, 1953; Coplen and others, 1991; Coplen, 1994
Stable isotopes of nitrate	Bacterial conversion of nitrate to nitrous oxide and mass spectrometry	USGS Stable Isotope Laboratory, Reston, Virginia, lab code 2900	Casciotti and others, 2002
Carbon isotopes	Accelerator mass spectrometry	University of Waterloo, Environmental Isotope Laboratory; University of Arizona Accelerator Mass Spectrometry Laboratory, Schedule 2015	Donahue and others, 1990; Jull and others, 2004
Radioactivity and gases			
Radon-222	Liquid scintillation counting	NWQL, Lab code 1369	American Society for Testing and Materials, 1998a, b
Radium 226/228	Alpha activity counting	Eberline Analytical Services, NWQL, Schedule 1262	U.S. Environmental Protection Agency, 1980 (USEPA methods 903 and 904)
Gross alpha and beta radioactivity	Alpha and beta activity counting	Eberline Analytical Services, NWQL, schedule 1792	U.S. Environmental Protection Agency, 1980 (USEPA method 900.0)
Tritium	Electrolytic enrichment-liquid scintillation	USGS Stable Isotope and Tritium Laboratory, Menlo Park, California, Lab code 1565	Thatcher and others, 1977
Tritium and noble gases	Helium-3 in-growth and mass spectrometry	Lawrence Livermore National Laboratory	Clarke and others, 1976; Moran and others, 2002; Eaton and others, 2004
Uranium-234, -235, -238	Alpha particle spectrometry	Eberline Analytical Services, Schedule 1130	American Society for Testing and Materials, 2005, Method D3972
Microbial constituents			
F-specific and somatic coliphage	Single-agar layer (SAL) and two-step enrichment methods	USGS Ohio Water Microbiology Laboratory, Method 1601	U.S. Environmental Protection Agency, 2001
Total and <i>Escherichia</i> coliform	Membrane filter technique with "MI agar", colony counting	USGS field measurement	U.S. Environmental Protection Agency, 2002b

Table A2. Preferred analytical schedules for constituents appearing on multiple schedules for samples collected for the Southeast San Joaquin Valley Groundwater Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.

[Preferred analytical schedules usually are the methods of analysis with the greatest accuracy and precision out of the ones used for the compound in question. Abbreviations: MWH, Montgomery-Watson-Harza Laboratory; LLNL, Lawrence-Livermore National Laboratory; SITL, U.S. Geological Survey Stable Isotope and Tritium Laboratory; TML, U.S. Geological Survey Trace Metal Laboratory, Boulder, Colorado; VOC, volatile organic compound]

Constituent	Primary constituent classification	Analytical schedules	Preferred analytical schedule
Results from preferred method reported			
Acetone	VOC, gasoline oxygenate degradate	2020, 4024	2020
Diisopropyl ether	VOC, gasoline oxygenate	2020, 4024	2020
Ethyl <i>tert</i> -butyl ether (ETBE)	VOC, gasoline oxygenate	2020, 4024	2020
Methyl <i>tert</i> -butyl ether (MTBE)	VOC, gasoline oxygenate	2020, 4024	2020
Methyl <i>tert</i> -pentyl ether (TAME)	VOC, gasoline oxygenate	2020, 4024	2020
DBCP (1,2-Dibromo-3-chloropropane)	VOC, fumigant	2020, 1306	1306
EDB (1,2-Dibromoethane)	VOC, fumigant	2020, 1306	1306
Atrazine	Pesticide	2033, 2060	2033
Carbaryl	Pesticide	2033, 2060	2033
Deethylatrazine (2-Chloro-4-isopropylamino-6-amino- <i>s</i> -triazine)	Pesticide degradate	2033, 2060	2033
Metalaxyl	Pesticide	2033, 2060	2060
Results from both methods reported			
1,2,3-Trichloropropane (1,2,3-TCP)	VOC	2020, MWH	MWH
Arsenic, total	trace element	1948, TML	1948
Chromium, total	trace element	1948, TML	1948
Iron, total	trace element	1948, TML	1948
Tritium	Radioactive	LLNL, SITL	—

Table A3. Quality-control summary for constituents detected in blanks collected for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.

[Censored data are reported but not used in summary statistics; mg/L, milligrams per liter; µg/L, micrograms per liter; pCi/L, picocuries per liter; E, estimated value; nr, not reported].

Constituent	Number of field blank detections/analyses	Maximum concentration detected in field blanks	Minimum concentration detected in ground-water samples	Number of ground-water samples censored
Volatile organic compounds and gasoline additives and (or) oxygenates (µg/L)				
Acetone	1/11	27	6	0
2-Butanone (Methyl ethyl ketone)	2/11	3.3	28.1	0
Ethylbenzene	3/11	E 0.06	E 0.04	0
<i>m</i> -Xylene plus <i>p</i> -xylene	3/11	0.37	E 0.01	1
<i>o</i> -Xylene	1/11	E 0.03	E 0.06	0
Tetrachloroethene (PCE)	1/11	E 0.03	E 0.02	0
Toluene ¹	6/11	0.23	E 0.01	2
Trichloroethene (TCE)	1/11	E 0.02	E 0.03	0
Trichloromethane (chloroform)	2/11	E 0.04	E 0.01	0
Pesticides and (or) pesticide degradates (µg/L)				
Caffeine	3/6	E 0.011	E 0.004	6
Major and minor ions (mg/L)				
Calcium	6/6	0.53	0.87	0
Magnesium	6/6	0.014	0.01	1
Sodium	6/6	1.04	7	0
Silica	6/6	6.16	14	0
Residue on evaporation	2/6	10	91	0
Trace elements (µg/L)				
Aluminum ²	6/6	nr	E 0.8	0
Barium ²	1/6	nr	2	0
Beryllium	1/6	E 0.05	E 0.03	0
Chromium	6/6	0.47	E 0.03	0
Cobalt	1/6	0.13	E 0.02	1
Copper	4/6	3.20	E 0.2	3
Iron	5/6	36	E 3	0
Lead	5/6	0.26	E 0.04	3
Manganese	5/6	0.20	E 0.01	0
Nickel	4/6	0.42	E 0.03	1
Strontium ²	6/6	nr	14	0
Tungsten	2/6	0.38	E 0.04	0
Vanadium	1/6	0.21	1.40	0
Zinc	3/6	4.80	E 0.03	0
Chromium (VI) ³	6/6	46	1.00	all
Nutrients and dissolved organic carbon (mg/L)				
Dissolved organic carbon (DOC)	2/2	0.19	E 0.20	3
Total nitrogen (nitrate + nitrite + ammonia + organic-nitrogen)	1/3	0.12	0.06	0

¹ Constituents also detected in associated source solution blanks.

² Constituents detected in universal blank water tested by the National Water Quality Lab (U.S. Geological Survey, 2006). Environmental data were not censored.

³Chromium (VI) analyses made by U.S. Geological Survey's Trace Metal Laboratory.

Table A4. Quality-control summary of replicate analyses of constituents detected in samples collected for the Southeast San Joaquin Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.

[RSD, relative standard deviation; µg/L, micrograms per liter; VOCs, volatile organic compounds; E, estimated value; na, not available; —, not detected]

Constituent	Number of relative standard deviations greater than 20 percent/replicate pairs	Maximum relative standard deviation (percent)	Median of relative standard deviations (percent)	Concentrations for replicate pairs with RSD greater than 20 (environmental, replicate) (µg/L)
Volatile organic compounds, gasoline oxygenates and additives from schedules 2020 and 4024				
VOCs	0/9	6	0	na
Pesticides and pesticide degradates from schedules 2033 and 2060				
3,4-Dichloroaniline	1/9	21	0	(0.019, 0.014)
Deethyldeisopropyl atrazine (Chlorodiamino- <i>s</i> -triazine)	1/5	20	0	(E0.08, E0.06)
Constituents of special interest				
Perchlorate	0/10	12	0	na
1,2,3-Trichloropropane	1/6	103	0	(—, 0.032)
<i>N</i> -Nitrosodimethylamine	0/6	4	0	na
Major ions, minor ions, trace elements, and nutrients				
Major and minor ions	0/5	17	0	na
Boron	1/5	21	4	(23,17)
Cadmium	1/5	47	0	(0.04, E0.02)
Iron	2/5	66	0	(E4,11)(15,11)
Lead	1/5	23	0	(0.91,0.66)
Molybdenum	1/5	40	0	(8.4,4.7)
Nickel	1/5	42	11	(26.9,14.6)
Zinc	1/5	22	18	(1.1,0.8)
As(III)	1/5	24	0	(2.4,1.7)
Nutrients	0/5	16	0	na
Isotopes, radioactivity, and noble gases				
δ ¹⁸ O in nitrate	1/4	35	14	(1.4,0.84)
Radium-228	2/3	41	29	(0.36,0.24)(0.15,0.27)
Alpha radioactivity—72 hour count	1/3	78	4	(1.39,0.4)
Alpha radioactivity—30 day count	2/3	27	21	(11.3,8.4)(0.19,1.13)
Beta radioactivity—72 hour count	1/3	104	9	(1.9,0.3)
Beta radioactivity—30 day count	2/3	82	24	(4.0,2.8)(0.47,1.79)
Uranium-234	1/5	25	1	(0.036,0.025)
Uranium-235	1/5	141	14	(0,0.045)
Uranium-238	1/5	67	1	(0.026,0.074)
Microbial indicators				
F-specific and somatic coliphage, E. Coli, and total coliforms	0/2	0	0.0	na

Table A5. Quality-control summary of matrix-spike recoveries for volatile organic compounds, gasoline oxygenates and their degradates, *N*-Nitrosodimethylamine (NDMA), and 1,2,3-Trichloropropane added to samples collected for the Southeast San Joaquin Valley Groundwater Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.

[Acceptable recovery range is between 70 and 130 percent, only constituents outside of acceptable range are given; na, not applicable]

Constituent	Number of spike samples	Minimum recovery (percent)	Maximum recovery (percent)	Median recovery (percent)
Volatile Organic Compounds				
1,2-Dibromo-3-chloropropane (DBCP) ¹	18	43	114	97
Bromoethene	9	117	138	133
Bromomethane (methyl bromide)	9	102	155	131
Chloromethane	9	94	144	138
Iodomethane	9	75	147	103
Naphthalene	9	104	134	113
Trichlorofluoromethane ¹	9	94	131	120
Pesticide Compounds				
Azinphos-methyl	7	47	83	52
Azinphos-methyl-oxon	7	29	56	40
Benfluralin	7	43	67	57
4-Chloro-2-methylphenol	7	31	59	54
Chlorpyrifos oxygen analog	7	0	30	19
Cyfluthrin	7	32	59	39
λ-Cyhalothrin	7	16	30	21
Cypermethrin	7	31	57	39
Deethylatrazine (2-Chloro-4-isopropylamino-6-amino- <i>s</i> -triazine) ¹	7	32	41	39
Desulfinyl fipronil ¹	7	35	47	41
Desulfinylfipronil amide	7	25	46	28
Diazinon, oxon	7	60	85	69
Dichlorvos	7	9	40	29
Dicrotophos	7	19	39	28
Dimethoate	7	20	29	27
Disulfoton	7	28	58	40
Disulfoton sulfone	7	68	104	80
Ethion	7	55	104	68
Ethion monoxon	7	51	104	70
Fenamiphos	7	60	104	69
Fenamiphos sulfone	7	39	90	53
Fenamiphos sulfoxide	7	40	75	48
Fipronil	7	61	102	63
Fipronil sulfide ¹	7	33	53	37
Fipronil sulfone	7	24	42	29
Hexazinone ¹	7	56	84	63
Iprodione	7	9	24	18
Malaoxon	7	41	81	68
Metribuzin	7	65	78	67
Myclobutanil ¹	7	66	100	71
1-Naphthol ¹	7	5	30	10
Oxyfluorfen	7	43	76	52
Paraoxon-methyl	7	39	60	49
Parathion-methyl	7	57	91	71
Pendimethalin	7	59	122	78
<i>cis</i> -Permethrin	7	36	65	47
Phorate	7	40	69	50
Phorate oxon	7	59	78	66
Phosmet	1	8	8	8
Phosmet oxon	1	51	51	51

Table A5. Quality-control summary of matrix-spike recoveries for volatile organic compounds, gasoline oxygenates and their degradates, *N*-Nitrosodimethylamine (NDMA), and 1,2,3-Trichloropropane added to samples collected for the Southeast San Joaquin Valley Groundwater Ambient Monitoring and Assessment (GAMA) study, California, October 2005 through February 2006.—Continued

[Acceptable recovery range is between 70 and 130 percent, only constituents outside of acceptable range are given; na, not applicable]

Constituent	Number of spike samples	Minimum recovery (percent)	Maximum recovery (percent)	Median recovery (percent)
Propargite	7	50	94	69
<i>cis</i> -Propiconazole	7	16	32	21
<i>trans</i> -Propiconazole	7	51	85	60
Tebuconazole	7	39	85	50
Tefluthrin	7	30	47	43
Terbufos	7	59	78	71
Terbufos oxygen analog sulfone	7	61	104	78
Tribuphos	7	42	77	48
Trifluralin	7	50	72	63
Polar Pesticide Compounds				
Acifluorifen	3	136	152	140
Aldicarb	3	50	61	56
Aldicarb sulfoxide	3	84	140	88
Benomyl	3	58	93	91
Bensulfuron	3	107	188	109
Bromacil ¹	3	65	107	101
Chlorimuron-ethyl	3	81	172	81
Chlorodiamino- <i>s</i> -triazine	3	83	134	97
Deethylatrazine (2-Chloro- 4-isopropylamino-6- amino- <i>s</i> -triazine) ¹	3	65	78	77
2,4-D	3	131	142	136
DCPA (Dacthal) monoacid	3	97	142	123
Deisopropyl atrazine (2-Chloro-6-ethylamino- 4-amino- <i>s</i> -triazine) ¹	3	65	71	70
Dinoseb ¹	3	111	180	132
Flumetsulam	3	19	163	159
Hydroxyatrazine (2-Hydroxy-4- isopropylamino-6- ethylamino- <i>s</i> -triazine)	2	125	144	134
Imazaquin	3	91	172	120
Imazethapyr ¹	3	116	149	119
Imidacloprid	3	123	140	138
Methomyl	3	31	116	55
Metsulfuron ¹	3	48	77	62
Nicosulfuron	3	99	284	136
Norfluazon	3	107	140	130
Sulfometuron	3	99	195	104
Triclopyr	3	115	134	116
Microbial constituents				
F-specific coliphage	2	detected ²	na	na
Somatic coliphage	2	detected ²	na	na

¹ Constituents detected in ground-water samples.² A detection indicates the ground-water matrix does not affect the detection of coliphage.

Table A6. Quality-control summary for surrogate recoveries of volatile organic compounds (VOC), gasoline oxygenates and their degradates, pesticides and pesticide degradates, and constituents of special interest added to samples collected for the Southeast San Joaquin Valley study area, California, October 2005 through February 2006.

[MWH, Montgomery Watson Harza Laboratory; VOC, volatile organic compound; 1,2,3-TCP, 1,2,3-Trichloropropane; NDMA, N-Nitrosodimethylamine]

Constituent	Analytical schedule	Constituent or constituent class analyzed	Number of blank analyses	Median recovery in blanks (percent)		Number of surrogate recoveries below 70 percent in blanks		Number of sample analyses	Median recovery of samples (percent)		Number of surrogate recoveries below 70 percent in samples		Number of surrogate recoveries above 130 percent in samples	
1,2-Dichloroethane- <i>d</i> 4	2020, 4024	VOC, gas	21	100	0	0	2	134	101	0	0	11		
		oxygenate												
1-Bromo-4-fluorobenzene	2020, 4024	VOC, gas	21	97	2	0	0	134	95	10	0	0		
		oxygenate												
Toluene- <i>d</i> 8	2020, 4024	VOC, gas	21	100	0	0	0	134	100	0	0	0		
		oxygenate												
Isobutyl alcohol- <i>d</i> 6	4024	Gas oxygenate	4	89	0	0	0	27	86	0	0	0		
α -HCH- <i>d</i> 6	2033	Pesticide	11	78	0	0	0	105	81	2	0	0		
Diazinon- <i>d</i> 10	2033	Pesticide	11	80	1	0	0	105	81	15	0	0		
2,4,5-T	2060	Pesticide	6	128	0	1	1	49	130	0	0	21		
Barban	2060	Pesticide	6	99	0	0	0	49	101	1	0	0		
Caffeine- ¹³ C	2060	Pesticide	6	113	0	3	3	49	114	0	0	7		
N-Nitrosodimethylamine- <i>d</i> 6	MWH	NDMA	12	114	0	0	0	51	94	2	1	1		
Toluene- <i>d</i> 8	MWH	1,2,3-TCP	12	99	0	0	0	50	98	0	0	2		

